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Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.


THE CHICAGO DRAINAGE COMMISSION, in its last report, says that, in addition to the $26,800,000 estimated by Engineers NEWTON and WORTHEN for a 14-ft. channel in earth and 18 ft. channel in rock, further sums must be added for right of way, dumping grounds, transportation, straightening the South Branch, changing bridges, etc. The total cost thus figured up is $30,000,000. They say there is no provision under the law for raising any such sum, and they think that a cut of 18 ft. through rock and 160 ft. wide involves a cost wholly unnecessary. The cut thus proposed would carry 750,000 cu. ft. per minute, while the law demands only 300,000 cu. ft. in the same time. The Commission states that it will be time enough to make this deep channel when the general government demands it and takes part in its execution; and that meanwhile a channel can be constructed of width and depth sufficient to pass 300,000 cu. ft. per minute, with a saving of $7,000,000 to $10,000,000 in the rock alone, and a corresponding saving in the earth work. The Commission submits these views to the people, and suggests that the law be amended so that they may execute this work in the most practical and economical way. Engineer WORTHEN is to submit a detailed estimate of cost of the smaller channel.

THE BROOKLYN BRIDGE receipts in February were $92,773.37, which is $6,193.24 more than the receipts in February, 1890. During the same period 3,156,450 passengers were carried on the cars and 212,402 persons used the promenade. The expenditures were $77,727.61. The claim of the late Col. W. H. PAINE for $5,000 for the use of his patent cable grip, etc., has been referred to the Controllers of New York and Brooklyn for examination.

THE WOODEN STEAMER *Ferdinand Schlesinger*, the largest on the lakes, was launched at Wolf & Davidson's shipyard, Milwaukee, last week. This vessel is 328 ft. long on the keel, 42 ft. beam and 27 ft. depth of hold. The engines are triple expansion, with 21, 34 and 57 in. cylinders and 42 in. stroke, furnished with steam at 160 lbs. The propeller is of sectional pattern, 13 ft. in diameter and 15½ ft. pitch. The carrying capacity is about 3,000 tons of iron ore. The bottom of this ship is provided with compartments for carrying 550 tons of water ballast.

A PASSENGER CAR without end platforms has been patented by Mr. E. H. BECKLEY, of Elkhart, Ind. At each end of the car are side doors at the bottom of the ordinary steps, the doors being flush with the side of the car and opening inward. The steps may be covered by a trap door while the train is running. In the end of the car is a door and vestibule arrangement affording communication between the cars.

THE TANSA DAM for the water supply of Bombay, India, is nearly completed, and work is in progress on the iron pipe line 60 miles long to convey the water from the reservoir to the city. The dimensions of this dam were given in ENGINEERING NEWS, Dec. 20, 1890.

THE MANCHESTER SHIP CANAL CO. has expended over $45,000,000. More money is wanted at once, and it is stated that the City Council of Manchester will advance the $10,000,000 needed to complete the canal. The money must be secured by Aug. 15 next; otherwise the men must be discharged and the plant, valued at $5,000,000, will be idle.

A SIXTEEN-STORY BUILDING, 215 ft. high, is to be built on ground 60 ft. front by 182 ft. deep on Washington St., in Chicago. The land cost $525,000, or about $48 per sq. ft., which valuation is referred to as "low" in comparison with neighboring properties. The structure will be brick and terra cotta over a steel frame, and will contain 400 to 500 offices. Work is to commence June 1 next, and it is to be ready for occupation by May, 1892.

NICKEL STEEL ARMOR MAKERS, in this country, are to contest a claim for 2 cts. per pound royalty, set up by a European syndicate under their patents covering the process. This claim will be contested by Carnegie, Phipps & Co., who claim that their process is not covered by the Schneider patents. Pending the dispute the Government shall retain the amount claimed as royalty, in its contracts for nickel steel armor plate.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was another car-stove accident, a derailment of a fast passenger train on the Jacksonville Southeastern Ry., near Havana, Ill., on March 8. A broken rail is said to have caused the accident. The train consisted of a baggage and express car, a smoking car, a chair car and 2 sleeping cars. All the cars were burned. The baggage car was set on fire by the stove, and the chair car caught fire from its heater. The entire train was derailed, the cars being thrown on their sides. The fireman was killed, and about 8 persons seriously injured, 2 of them dying shortly after the accident. Several other persons were slightly injured.

A LOCOMOTIVE BOILER EXPLOSION occurred March 8 on the Albany & Susquehanna division of the Delaware & Hudson road. The engine was hauling a train near Central Bridge, N. Y. Three men were badly scalded. It is reported that the crown sheet collapsed.

A BAGGAGE AND MAIL CAR on the Chicago express over the New York Central & Hudson River R. R. caught fire March 9 while the train was running between Schenectady and Amsterdam, N. Y. The fire was put out by the fire department at Amsterdam, but a large quantity of baggage and mail matter was destroyed. The fire is said to have been started by a lamp. An overheated stove set fire to a car standing on the track at Centre Station, Mass., on the Boston & Maine R. R. March 8, and 4 cars were burned.

THE DAM of the Honey Lake Water Co. on Skeddaddle Creek, near Susanville, Cal., was carried away by the recent floods.

A TRESTLE on the Chattanooga, Rome & Columbus R. R. over the Tallapoosa River, near Buchanan, Ga., gave way under a freight train March 4. The trestle caught fire and was destroyed. A number of bridges in the southern states have been destroyed or damaged by the floods.

THE INSTRUCTIONS TO ENGINEERS and prices used for estimating on the Mexican Southern Ry. are (in part) as follows: Maximum curve 17° 32' = 100 meter radius. The cañons being very tortuous, and the slopes very steep, the recurrence of the maximum curve is remarkably frequent. Maximum grade, on tangents and curves of greater radius than 100 m., 4%; on curves of less radius than 110 m., 3.75%. Width of roadbed: embankment, 3.6 m.; excavation, 4 m. Gage of track, 3 ft. Weight of rail, 40 lbs. per yard. Prices per cu. yd.: earth excavation and borrow, 15 cts.; loose rock, 50 cts.; solid rock, $1.25; masonry, 1st class, $15; 2d class, $10; 3d class, $7; iron bridges, $125 per ton. The following is the preliminary estimate by sections for grading and bridging: Section 1, 28 kilos., $16,500 per kilo.; section 2, 15 kilos., $19,500 per kilo.; section 3, 20 kilos., $18,000 per kilo.; section 4, 43 kilos., $11,700 per kilo.; section 5, 37 kilos., light. The Tomeyin cañon proper is 14 kilos. in length, with an average descent of 2.3%. While the descent is not quite uniform, there are no falls worthy of the name, nor continuous rapids, appearing to make possible (as believed by a correspondent) a somewhat less maximum grade than that which is employed, 4%.

THE CENTENNIAL OF THE ESTABLISHMENT OF THE PATENT SYSTEM in the United States is to take place at Washington, D. C., on April 8, 9 and 10, as noticed more fully in our issue of Feb. 14. It is now announced that the attendance promises to be so large that admission to the public meetings, the reception and the excursions to Mt. Vernon will have to be by ticket. Persons desiring to attend the meetings and participate in the receptions and excursions should write at once to J. ELFRETH WATKINS, Secretary of the Executive Committee in charge of the celebration, 811 G street, N. W., Washington, and apply for the necessary tickets.

ALUMINUM AT $1 PER POUND, for any quantity, is the latest special announcement of change of price by the Pittsburg Reduction Co., Mr. ALFRED E. HUNT, President. At this rate, aluminum is much cheaper than nickel or German silver, when weights are compared, and is nearly as cheap as copper. At the figures quoted, aluminum should be found economical for many purposes for which other and less objectionable metals are now used.

THE PROPOSED ABOLITION OF THE MICHIGAN STATE BOARD OF HEALTH is deservedly meeting with great opposition, and is calling forth letters of disapproval from all over the country. It seems that economy is the plea for abolition. The work of the board, and of its Secretary, H. B. BAKER, has been highly appreciated, both in this country and abroad, and if economy is the aim of the legislature, it should increase present appropriations for the work of the board rather than abolish it.

AN EIFFEL TOWER UPSIDE DOWN is the somewhat startling novelty offered to the World's Fair Commission by a Kansas City engineer, Mr. HASTINGS. This plan calls for a tower 940 ft. high, with a diameter of 20 ft. at the ground and 200 ft. near the top. It is an umbrella, in fact, standing on the handle; and to keep it in this position Mr. HASTINGS would depend on stout cable guys. We are inclined to agree with the Kansas City *Times* in the belief that if anything went wrong with these guys "it would not take more than three agitations of the atmosphere before there would be old iron for sale."

AN EAST RIVER BRIDGE COMMISSION is proposed in a bill now before the New York Legislature, which is a surprise to those now seeking bridge franchises over this river. The bill authorizes Mayor GRANT to appoint a commission who with ANDREW H. GREEN, CHARLES M. VAIL and GEORGE YOUNG shall have power to examine plans, locate any bridge and its approaches, and organize such company to construct the bridge as they see fit. The commissioners can fix the amount of capital stock to be subscribed before the new company secures the franchise to build the bridge. This franchise is fixed by the majority vote of the commission. The company securing the right to build is to pay to the cities of New York and Brooklyn, each, 2½% of the gross amount of annual receipts. The bill grants unlimited powers and is not at all likely to pass.

## Notes On English Railways.

(*Continued from p. 197.*)

### GREAT WESTERN RAILWAY.

*Track. (Correction).*—The quantities of timber per mile of track given on p. 174 are incorrect owing to an error in calculation. The correct figures are as follows:

| *Track.* | *Size of ties.* | *Ft. B. M.* |
|---|---|---|
| S. gage; 2,112 ties per mile. | 9 ft. × 10 × 5 ins. | 79,166 |
| B. or M. gage; 2,112 " | 11 ft. × 10 × 5 ins. | 96,800 |
| S. gage; 2,640 " | 8½ ft. × 8 × 6 ins. | 89,760 |
| B. " | longitudinals, 15 ins. × 7 × 7½ ins. | 141,328 |
| M. " | transoms 6 ft. × 6 × 6 ins. | 198,572 |

### GREAT EASTERN RAILWAY.

This railway was organized some years ago by the amalgamation of a number of smaller lines, and has now an aggregate of 1,021 miles. It was at one time in bad condition financially and practically, but good engineering and good management have made it now a valuable property. It has three or four main routes, including a line running as far north as Doncaster, 182¼ miles from London, and a network of cross-country lines, the longest direct route on which is from Doncaster to Yarmouth, 183 miles. Around London the company has an enormous local and suburban traffic, and great efforts are being made to accommodate and build up this traffic. The line runs to several seaside resorts on the east coast, some of which have been practically established by the railway, and has therefore a large summer and excursion traffic, while it has also a heavy traffic in fish from the coast. At Parkeston, near Harwich, 69 miles from London, the company has established a harbor and runs lines of steamers to Hamburg, Rotterdam and Antwerp. Among the principal places on this system are Colchester, 51 miles from London; Cambridge, 56 miles; Ipswich, 69 miles; Norwich, 125 miles; Lincoln, 145 miles; Doncaster, 182¼ miles; Peterboro and Newmarket; while on the coast are Harwich, Parkeston, Lynn, 98 miles; Lowestoft, 118 miles; Yarmouth, 122 miles, and Cromer, 139 miles. A part of the old line was originally laid with a gage of 5 ft. The road has a very heavy traffic of all kinds. The company has adopted a liberal policy, making a specialty of cheap fares, fast trains, ample train service, and numerous concessions to the third class traffic, while it spends large sums of money in the improvement of its line and equipment. The favorable results of this policy are shown by the improved financial condition and by the heavy and growing traffic. The Liverpool St. terminus, one of the largest terminal stations in London, is being enlarged at a cost of about $3,500,000 for land and $2,000,000 for construction, and its capacity will be increased nearly 50%. The whole line from this station to Stratford, about 7 miles distant, at which point several lines branch off, is being widened to have 6 tracks. This involves some very difficult work, as the line runs through a densely populated part of the city, and the traffic is almost continual on the existing 4 tracks. For some distance from the terminus the line is below the level of the streets, in open cutting or covered way, and then rises by a grade of 1 in 70 (1.43%) to a brick viaduct, with iron plate girder bridges across the streets. Trough floors are used on these bridges. There are many miles of these masonry viaducts around London; the majority of them are of yellow brick, made from the London clay. They have parapet walls about 4 ft. to 5 ft. high. A peculiar feature noted at the terminus was that the flat roof of the exit carriageway under the hotel is apparently supported by flat arch ribs of stone, the stones being dovetailed together. The company has experienced good results from the practice of giving its employees cottages or accommodations for lodging at a cheap rate, as it improves the discipline and makes them more desirous of remaining in the service. A number of cottages are, therefore, being erected on the company's property.

*Track.*—The line is laid with bull head steel rails weighing 80 and 85 lbs. per yd., carried in cast iron chairs weighing 43 lbs. each, which are fastened to the creosoted ties by 2 spikes and 2 trenails to each chair. On some sidetracks the chairs are fastened by hollow trenails, into each of which a round spike is driven. The wooden keys or wedges are driven on the outer side of the rail. There are 11 ties to a rail length of 30 ft.; the joint ties are spaced 25 ins. c. to c. and the intermediate ties 33½ ins. c. to c. The rails are laid with square suspended joints, spliced with deep splice bars, bent to embrace the lower head of the rail. There are 4 bolts, with button heads, square nuts and no washers. The nuts are on the outer side of the rail. Some of the older track has the inner splice bars grooved to hold the square heads of track bolts. Supported joints, with the rail ends carried on special chairs resting on the joint ties, have been tried near the Liverpool St. terminus in London. Steel ties of trough section, with cast-iron chairs, are being used to some extent. In one place near London, where extensive alterations were in progress, a number of these ties were noticed which had been taken out and stacked at the side of the line; but it was ascertained from Mr. WILSON, Chief Engineer, that they were not abandoned, but were to be put down again. The ballast is of broken stone, brought up level with the tops of the ties. The switch rods are of gas pipe, with screw and cotter couplings.

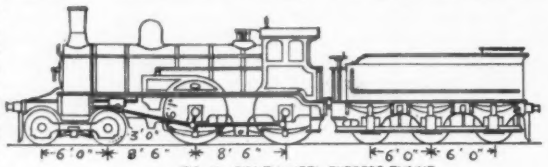


FIG. 14. EIGHT WHEEL EXPRESS ENGINE.

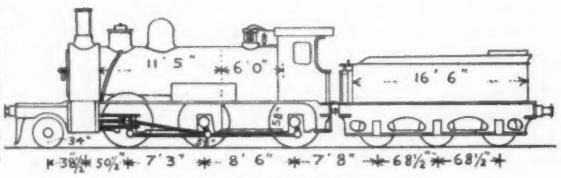


FIG. 15. MOGUL ENGINE.

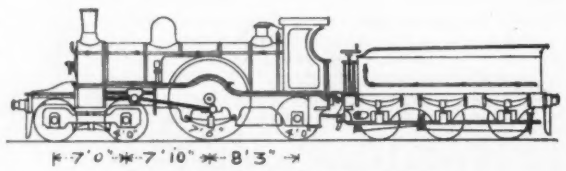


FIG. 16. SINGLE DRIVER EXPRESS ENGINE.

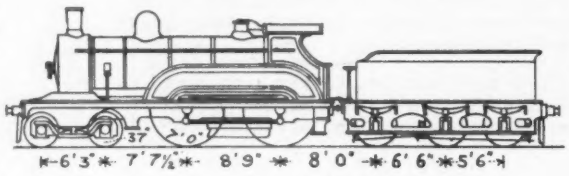


FIG. 17. COMPOUND EXPRESS ENGINE.

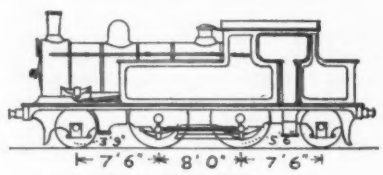


FIG. 18. TANK ENGINE.

LOCOMOTIVES; GREAT EASTERN RAILWAY, ENGLAND.

*Locomotives.*—The road has a very fine equipment of locomotives of all classes. In 1864, some passenger engines, with 4 coupled driving wheels and a single pair of leading wheels, were built by Mr. SINCLAIR. These engines were rebuilt by Mr. ADAMS in 1878, and a four-wheel truck or "bogie" was substituted for the single leading axle. They are not strong enough, however, for present requirements and have lately been confined to branch line traffic; they are being rapidly replaced with engines of the present standard type. The late Mr. MASSEY BROMLEY, when Locomotive Superintendent, introduced some novel features in English practice, as the result of his experience in the United States. The engines shown in Figs. 14 and 15, which were brought out by him between 1870 and 1880, have a decidedly American appearance. Fig. 14 is an outside cylinder engine, with a four wheel leading truck and 4 coupled wheels, the springs of which are connected by equalizing levers. The cab is of a form rarely seen on English roads. The dimensions are as follows: Cylinder, 18 × 26 ins.; driving wheels, 6 ft. 1 in. diameter; heating surface, 1,314 sq. ft.; weight in working order, 96,320 lbs. The tender weighs 56,000 lbs. and carries 2,400 galls. (2,877 U. S. galls.) of water. Fig. 15 shows an engine of the American mogul type; cylinders, 19 × 26 ins.; driving wheels, 4 ft. 10 ins. diameter; truck wheels, 2 ft. 10 ins. diameter; heating surface, 1,393 sq. ft.; weight in working order, 107,184 lbs. The tender weighs 71,680 lbs. and carries 2,500 galls. (3,000 U. S. galls.) of water. Fig. 16 shows an outside cylinder express engine, also designed by Mr. BROMLEY, having a single pair of driving wheels and a four-wheel leading truck. Cylinders, 18 × 24 ins.; driving wheels, 7 ft. 6 ins. diameter; truck and trailing wheels, 4 ft. diameter; heating surface, 1,208 sq. ft.; weight, 94,080 lbs. There were originally 20 of these engines, and the majority are still running. Some work the fast trains for the north, between Cambridge and Doncaster, 127 miles.

The compound system was introduced on this road by Mr. T. W. WORSDELL, who also introduced it on the Northeastern Ry. when he became Locomotive Superintendent of that line after leaving the Great Eastern Ry. He adopted the two-cylinder system, some special appliances for which he patented in conjunction with Mr. VON BORRIES, of Austria, and which system is now generally known in England as the Worsdell-Von Borries system; though it may be more properly called the Mallet system, of which it is one of the sub-types. This system has been applied to express, freight and tank engines. The cylinders are inside the frames, under the smokebox. All the compound express engines, numbering 11, have four-wheel trucks, and these engines together with the four-coupled simple engines built by Mr. WORSDELL, have the Joy valve gear and 4 slide bars to each cylinder. Some of these engines have the slide valves on top of the cylinders, instead of between them, as in ordinary English practice. One of the compound express engines is shown in Fig. 17. Cylinders, 18×24 ins. and 26×24 ins.; driving wheels, 7 ft. diameter; truck wheels, 3 ft. 1 in. diameter; boiler pressure, 160 lbs. per sq. in.; heating surface, 1,200 sq. ft.; weight, 99,680 lbs. The majority of the engines now in use have inside cylinders, and Mr. HOLDEN, the present Locomotive Superintendent, states that he is not building any more with outside cylinders. The equipment includes a large number of side-tank engines, mainly of three classes, as follows: 1, with six wheels, all coupled; 2, with four wheels coupled and a four-wheel trailing truck; 3, with four wheels coupled and a single radial leading and trailing axle. An engine of this latter class is shown in Fig. 18: cylinders, 18 × 24 ins.; driving wheels, 5 ft. 6 ins. diameter; leading and trailing wheels, 3 ft. 9 ins. diameter; heating surface, 1,054 sq. ft.; weight, 92,176 lbs. It is fitted with the Joy valve gear. Mr. HOLDEN's present standard type of passenger engine, shown in Fig. 19, has four coupled driving wheels and a single pair of leading wheels. The dimensions are as follows: Cylinders, 18 × 24 ins.; driving wheels, 7 ft. diameter; leading wheels, 4 ft. diameter; boiler, 4 ft. 2 ins. diameter; firebox, 6 ft. long; 256 tubes, 1⅝ ins. diameter and about 10 ft. long; height from rail to top of smokestack, 12 ft. 11 ins.; driving wheel base, 8 ft. 9 ins.; total wheel base, 16 ft. 6 ins. Heating surface: tubes, 1,124 sq. ft.; firebox, 106 sq. ft.; total, 1,230 sq. ft. Weight in working order, 98,112 lbs. The tender is carried on 6 wheels 4 ft. diameter, with a wheel base of 12 ft. It weighs 73,780 lbs. loaded, and the tank has a capacity of 2,755 galls. (3,303 U. S. galls.) of water. These engines have a single slide bar on each side, which is embraced by the upper part of the crosshead. They have the Stephenson link motion. Mr. HOLDEN has introduced with success a system for burning liquid fuel in locomotives, using coal

tar and shale oil which are obtained in considerable quantities from the company's gas works. The fuel is carried in the rear bunker, and is sprayed into the firebox by two injectors of a pattern designed and patented by Mr. HOLDEN. The jets intersect, A thin fire of coal or other solid fuel is maintained on the grate. The application of this system requires no alteration to the firebox or furnace, and Mr. HOLDEN considers this of great importance, as it permits the alternate use of liquid and solid fuel according to their market prices, and keeps uniform the system of lighting up. The latest engine fitted with this apparatus is a four coupled express engine, similar to that shown in Fig. 19. This engine takes regular turns on the fast express trains between London and Norwich, returning the same day, making a total mileage of 248½ miles. This liquid fuel system has been applied to several locomotives and stationary boilers, all in regular work, and is said to be giving good results. All the passenger engines are fitted with the Westinghouse automatic driver (spread) brake, and in the case of tender engines it is applied to the wheels of the tender as well as to those of the engine. The tenders are also fitted with the hand brake, applied by a hand wheel and screw; the connecting link at the lower end of the vertical rod moved by the hand wheel has a slot to allow the pin on the brake lever free travel when the air brake is applied. The leading, and sometimes the middle, wheels of the tender have the brake shoes on the leading side: the other wheels have the shoes on the trailing side. The company's locomotive and car works, printing offices, etc., are at Stratford, an eastern suburb of London. The engines have a very handsome appearance; the boiler, cab, wheels, splashers, frames and tanks or tender are painted a dark bright blue, with bright red striping, and a brass edging to the splashers. The smokebox and short, straight smokestack are black, the latter sometimes having a brass rim. The number plate and coupling rods are bright red, and on the side of the tank or tender are the initials of the road in gilt letters.

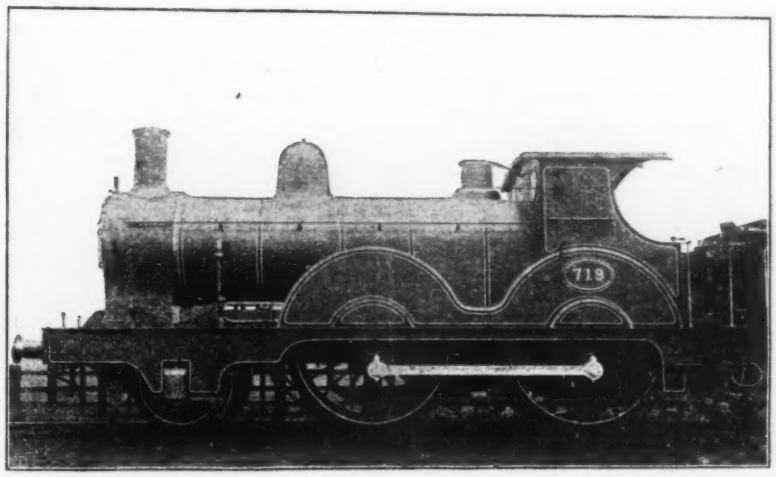



FIG 19. PASSENGER ENGINE; GREAT EASTERN RY., ENGLAND.

This engine is fitted for burning liquid fuel.

*Rolling Stock.*—The main line passenger cars are generally carried on 6 wheels, the middle axle having a sliding arrangement of the boxes. These cars have as a rule 6 third class, 5 second class or 4 first class compartments, seating 60, 50 or 32 passengers respectively. There are also composite cars with 2 first class and 2 second class compartments, and a baggage compartment; and others with first and second class compartments and a lavatory. For suburban traffic there are trains of 12 to 14 close coupled cars; these cars have generally 4 wheels each and 4 or 5 compartments. Mansell wheels are also almost universally adopted. The passenger cars are unpainted outside, having the natural wood rubbed down and varnished. They are of different shades of dark brown. The upholstery is in subdued colors, generally dark gray, and the window curtains are dark green. The Westinghouse automatic train brake is used. All the suburban trains are lighted by gas, some by the Pintsch and some by the Pope system. Gas has also been recently applied to several of the main line express trains. On this road, as on most English lines, a majority of the coal cars are owned by the different collieries, an arrangement which causes a good deal of trouble in returning the cars to the individual collieries. The Midland and Great Northern railways have bought up many of these cars, and find it an advantage to be able to send their own cars to any colliery that demands them.

*Steamers.*—The Antwerp boats, already referred to, are fast, well-built steamers, driven by twin screws. The passenger accommodations, however, as on most of the vessels of this class on English routes, leave very much to be desired. The cabins or saloons are small, inconvenient and badly ventilated, and the attendance and refreshment arrangements are very primitive. The cabins are all below the main deck. The second class cabin is a small one at the stern; it has two tables, with a very limited floor space, and on three sides are the double rows of bunks, two deep, in which such passengers as take care to secure a place can spend the night. The others have to manage on the sofas. Considering the large number of passengers traveling by this class, it seems strange that such very limited and inadequate accommodation should be provided. The American traveler misses the spacious saloons and dining rooms, comfortable staterooms, and the modern comforts and conveniences to be found on nearly all lines of river and coast steamers in the United States enjoying any considerable traffic. The "Colchester," one of the newest boats on this line, is 281 ft. long, 31 ft. beam, 15.2 ft. deep, with a draft of 10 ft. 6 ins. to 13 ft. 6 ins. Gross registered tonnage, 1,160. Displacement, 1,675 tons. She has two compound, surface condensing engines, with cylinders 30 and 57 ins. diameter and 36 ins. stroke. The propellers are 11 ft. 6 ins. diameter, with a pitch of 20 ft. 4½ ins. Steam is supplied by 2 double-ended boilers, 13 ft. diameter, 18 ft. 3 ins. long, each boiler having 6 furnaces 40 ins. diameter. There are 784 tubes, 3½ ins. diameter, 6 ft. 9 ins. long between tube plates. Heating surface of tubes, 4,770 sq. ft.; total heating surface, 5,820 sq. ft. Grate area, 220 sq. ft. Boiler pressure, 85 lbs. per sq. in. Her speed is about 14½ knots. The boats leave Antwerp about 5:30 P. M., and arrive at Parkeston about 3:30 A. M., when all the passengers are required to disembark together, instead of being allowed to wait, if they prefer, until a more seasonable hour, which is the ordinary practice on American steamers making runs of about the same time. After the baggage has been inspected by the Custom House officers a special express train carries the passengers to London. The designers and builders of English boats of this class appear to devote their attention mainly to the hull and machinery, and not to concern themselves much about the arrangement and fittings of the passenger accommodations, considering them apparently as a very secondary matter. E. E. R. T.

*[To be continued.]*

## A New Expedition towards the North Pole.

Civil Engineer ROBERT E. PEARY, U. S. N., recently Asst. Chief Engineer of the Nicaragua Canal, is about to undertake a most perilous task. He has made preparations to start on May 1 to lead an arctic expedition through the heart of Greenland, and has been granted leave of absence for 18 months from that date. He believes that, if he does not reach the pole itself, he will at least reach the highest latitude yet attained by any arctic expedition. He proposes to take a small body of picked men and go in an arctic whaler to the head of Inglefield Gulf, a deep indentation running into the west coast of Greenland from Whale Sound, north of Cape York. Here he will be landed with his men and supplies, and will establish a camp and supply depot. He will remain at this point until the spring of 1892, occupying himself in the meantime in determining upon the best route and establishing supply stations.

Mr. PEARY has been in the interior of Greenland before, having landed at Godhaven, on the west coast, some years ago and spent several months exploring the interior of this island. His acquaintance with the interior has led him to believe that he will find back from the coast a comparatively level route covered with ice, over which he can travel with much greater speed than would be possible if he followed the route of Lieut. LOCKWOOD, who traveled along the coast and was greatly impeded by being compelled to cross moving ice or make long detours around indentations in the shore line.

When Lieut. LOCKWOOD reached his furthest point north, about 83° 22', he found that there was every indication that the shore line of Greenland extended on in a northeasterly direction. How much further it goes can only be conjectured; but Mr. PEARY believes that by taking a northeasterly route from Whale Sound he will be able to reach the northernmost point of Greenland. How near the pole this will bring him is not known, and it is not certain that he will be able to go further; but if he finds the sea there covered with fixed ice, he will continue to the north, and may reach the pole.

However this may be, his expedition is almost certain to result in adding largely to the knowledge of the geographical world and of the interior of Greenland. Mr. PEARY will leave part of his party at Whale Sound to follow in his route and establish supply stations for him to fall back on on his return, and early in the spring of 1892 he will push forward by sledge with from three to five picked men and will go as far as he is able to travel by sledge. Then he will return and he expects to be back at Whale Sound in time to be picked up by a whaler returning at the close of the season.

The expense of the expedition will not be large, and is to be met by contributions from a number of geographical and scientific societies. Engineer-in-Chief MELVILLE, whose opinion on arctic matters is especially valuable on account of his experience on the *Jeannette*, believes that Mr. PEARY's plan is entirely practicable, and that he will be able to reach the limit of the land without much doubt, no matter how far north that may be. Mr. PEARY, if successful, will return to the United States in the fall of 1892. Engineers throughout the world will wish him success, but few will long to accompany him.

## Alaska.

The first report of Mr. IVAN PETROFF on the population, resources and industries of Alaska is presented in Census Bulletin No. 30. As far as returns have been received, this possession has a population of 21,929; but an aggregate of about 8,400 Eskimo will probably be added to this list. This population is divided into 4,419 white, 82 black, 1,598 mixed, 13,735 native, and 2,125 Chinese. The Chinese and 2,381 others are temporarily employed in the salmon canneries and whaling industries.

The district best known to tourists and containing all that there is of law courts, mail service, etc., embraces the territory lying between latitudes 54° 40 and 60° 0' north. This entire strip of mainland is mountainous in character, interspersed with huge glaciers. The Stikine is the only navigable stream on this coast. The superficial area is about 28,000 square miles, about the area of Maine; but the navigable waters between this coast and the innumerable islands of the Alexander archipelago has an aggregate length of two or three thousand miles. As the probable number of voters in this first district is only 960, and about 500 in all the other districts combined, politically speaking our Alaskan possessions have little importance.

## Reports of State Railroad Commissions.

### MAINE.

A little knowledge is a dangerous thing; and the little knowledge which the Maine Railroad Commission has gained on the subject of automatic car couplers has led it into serious error. We quote as follows:

> So far as appears no progress is being made in this state or throughout the country in the substitution of automatic freight car couplers in place of the link and pin. . . . So far as we can learn, no coupler of the vertical plane type so far used has given satisfaction by reason of structural weakness.

How far the first of the above statements is wide of the mark, the Commission may see by reference to our issue of Dec. 21, 1889, which showed over 56,000 cars equipped with M. C. B. couplers. Since that date the equipment of cars with the M. C. B. coupler has been going on very rapidly. We showed in our issue of Jan. 31 that eight companies alone, now having over 30,000 cars equipped with M. C. B. couplers, have equipped 9,458 of these cars during 1890; and we shall soon be able to give still more accurate information as to the rapid progress of the reform.

As to the other statement above quoted, to the effect that 'no vertical plane coupler has given satisfaction by reason of its structural weakness,' we confess we were hardly prepared for so frank an admission that the reason for the non-use of the coupler in New England is that it is too well able to stand hard knocks to suit its avowed enemies in that section. Perhaps, however, the Commission intended to say that all vertical couplers have been found lacking in strength. The grounds for this bold assertion are, we presume, to be found in the statement which we find close following the quotation above:

> No attempt has yet been made by any railroad corporation in this state or in New England to even give this type of coupler a trial, neither is there in New England any type of automatic coupler in use to-day.

It is most evident from this that the Commission must be condensing the results of a vast experience when its condemns the M. C. B. coupler on the score of weakness.

Unfortunately for the Commission's reputation for accuracy, the fact is that there are a considerable number of automatic couplers in use in New England, including quite a number of the M. C. P. type. Would it not be well for the Commission to consider the sage's advice, that "it is better not to know so many things, than to know so many things that are not so"?

Finally the Commission tacks on a clause to the effect that improvements in the vertical plane coupler since its adoption by the M. C. B. Association have made it "practical," and advises railway corporations to discard the link-and-pin without waiting to be compelled to do so by law!

The only other technical matter in the report of much importance is that on car heating. Maine is among the most progressive states in this reform, and steam from the locomotive is now generally used there, a fact of some importance in view of its heavy snowfall and severe winter climate.

A large part of the work of the Commission has been done in proceedings for the establishment of new grade crossings of highways and railways. The Maine law requires the approval of the Commission before any new grade crossing can be established. From the published proceedings, however, it appears that the Commission has been pretty lenient in the matter. In one case reported permission was given for a grade crossing on Main St. in the city of Rockland, where the railway company of its own accord afterward concluded the grades had better be separated in the original construction of the road.

### RHODE ISLAND.

Considering that the extent of the railways of Rhode Island is only 260 miles, the state is excusable for vesting their control in a single Commissioner. The report shows that this officer has endeavored to faithfully perform the duties of his office and use his influence in the furtherance of commendable reforms. The matter which is treated most fully and is of greatest interest, is the subject of grade crossings. There are now 234 grade crossings in the state (an average of nearly one per mile); but no new ones have been established during the year, thanks to the courage and good sense of the Commissioner, who was brave enough to refuse some urgent petitions for the establishment of several new crossings. The Commissioner is of the opinion that no new grade crossing should be made unless it is clearly shown that such a crossing is greatly needed, and that it cannot be made either over or under the railway except with very great trouble and expense.

With regard to reforms in brake and coupler practice and in car lighting and heating, the Commissioner favors National legislation; and he recommends the passage of resolutions by the Rhode Island Legislature, urging Congress to take action on the matter. There has been quite an advance during the year in the matter of car heating, 443 passenger cars being now warmed by steam, against 356 by heaters and 76 by stoves. This is an increase of 66 cars heated by steam and a decrease of 85 heaters and 17 common stoves. The law in Rhode Island forbids the use of common stoves or of any heater not approved by the Railroad Commissioner after Dec. 1 of this year. The Commissioner hints that he had much rather approve continuous heating systems than independent heaters of any pattern.

One serious accident occurred during the year, and the careful investigation which is reported is very creditable to the Commissioner. The accident was due to a collision between two sections of a broken freight train which shoved an iron beam against the side of a passenger train running on the other track, as described in ENGINEERING NEWS of Nov. 8, 1890.

### KANSAS.

The difference between the work of railway commissions in New England and in the West is very marked. In New England, as we have seen, the chief concern is the matter of safety and the lessening of the various accidents and injuries due to railway operations. In the West, matters of traffic rates first and then station and train accommodations are the things which occupy the time of the state railway commissions.

There is a reason for this, one of which is found in the fact that railway transportation in the West is a matter vital to every man's prosperity. The amount of money coming first to the farmers and secondarily to the merchants and professional classes who live off the farmers is fixed by the market prices of the staple farm products. Hence every penny charged for transporting the products to market is so much off the farmer's profits. Added to this is the fact that a great many miles of railway have been built in Kansas which are a blessing neither to the owners, who have spent money without a return, nor to the State, which has to support the roads.

It is noticeable that the Commission has recovered from its temporary exultation over the enormous railway mileage of Kansas. In the report for 1887 the Commission said:

> As a whole, we think the railroad systems of Kansas are well planned. Pushing out with unexampled energy into remote regions and in every direction, they open up vast possibilities to be utilized in the future.

"After the boom, the boomerang." The past three years have taught some severe lessons to the people of Kansas, and the report for 1890 says:

> The people of the state and owners of railroad securities are to be congratulated upon the indications that the mania for railroad building in Kansas is a thing of the past. The construction and maintenance of hundreds of miles of illogical and superfluous lines of road is bearing its legitimate fruit, and demonstrating so fully the unwisdom of the policy which prompted it as to preclude the probability of its repetition.

It is fair to say, however, that the commissioners were as little influenced by the flush times of 1887 as could be expected. They counseled moderation, and recommended in 1886 the repeal of the law permitting towns and cities to bond themselves in aid of railway enterprises. How serious this evil was may be seen by the fact that up to Nov. 1, 1886, which was before the boom reached its height, over $20,000,000 had been voted in aid of railway enterprises by counties, cities and townships. We look in vain for any statistics of the amount of debt with which Kansans have burdened themselves since that date to aid railway enterprises. Probably the Commission reasons, that now the harm is done, there is no use in reminding the people of their burden of debt.

Under the title "A Suggestive Review," the Commission makes an urgent plea to the Farmers' Alliance legislature, now in session in Kansas, not to enact any radical laws reducing railway rates.

The legislators are reminded that the people of Kansas were as much to blame as the railway companies for the construction of "1,500 miles of railroad, which is worse than worthless to its owners and a burden upon the commerce of the state." In many respects its review of the situation is a masterly one, but there are one or two weak points. The Commission overlooks the important fact that the great error of Kansas and of other Western States has been in its lax corporation laws, which have permitted railways to issue stocks and bonds as they pleased. All experience, both here and abroad, goes to show that if the state is to regulate the actions of public corporations, it ought to control the issue of securities and prevent the evils of stock watering. However, there is much more sound sense in the report than the Kansas legislators will be likely to appreciate. An elective railway commission and a forced reduction of rates to make them "as low as the lowest" is now the popular cry there. The Kansans may have been gulled when they bonded their cities and towns to build railways, but they will have their revenge on the "soulless corporations" yet, unless the courts interfere.

The accident statistics show that Kansas employees suffer fewer accidents and injuries than the average throughout the United States, due probably to the small amount of yard work. Passengers, however, do not get off so well, the casualties being higher than the average for the whole United States. Collisions during the year killed 12 passengers and 19 employees and injured 53 passengers and 64 employees. The accidents to trespassers are enormous; 70 were killed and 67 injured during the year. The statistics of the use of improved brakes and couplers on freight equipment show 38,758 cars with train brakes and 5,648 with automatic couplers.

## Dr. Otto and the Gas Engine.

DR. N. AUG. OTTO, the inventor of the Otto gas engine, died at Cologne, on Jan. 26, after a brief illness. Mr. OTTO started as a commercial traveler, for which duties his great mechanical skill was of little avail. Some circumstance turned his attention to gas engines. In 1867 he, in conjunction with EUGENE LANGEN, surprised the engineers who had flocked to the Paris Exhibition, with a practical gas engine, an engine of the vertical type, with flywheels on the top, not uncanny in appearance, but terribly noisy. Nine years after the "Otto Silent" was presented, and that engine has undergone manifold improvements by the inventor and by Messrs. CROSBY.

The gas engine in its practical career has thus quickly attained maturity. Yet the early history of the gas engine has to go back more than 200 years. It is orthodox to quote HUYGHENS as the first in the field. The series of originators commences, therefore, with one of the best names of physical science. Among the papers of the great physicist is one dated 1640, on a "Novel Motive Force Derived from Gunpowder and Air." PAPIN took this idea up in 1688, one year after his classical experiments which initiated the steam engine; but he was not satisfied with the result. Finally, a century later, STREET reopened the researches by bringing out and patenting a motor cylinder with explosion by means of a torch Many others followed, LEBON, SAMUEL BROWN, WRIGHT BARNETT, NEWTON, BARSANTI and MATTEUCCI, MILLION, and LENOIR and HUGON, who came very near producing a practical engine. But Langen and Otto's engine of 1867 was so decidedly superior in the economy of gas consumption that the Lenoir and Hugon engines were at once put out of the field. Otto's gas engine embraced the characteristic features of some of its predecessors—it is rarely otherwise in our days—the compression of BARNETT, the cycle of BEAU DE ROCHAS, and the free piston and other advantages of BARSANTI and MATTEUCCI'S engine, which was remarkable in many respects and effected ignition by means of the electric spark. But engineers remain indebted to Dr. OTTO for supplying an engine which realized and did what others, who deserve all credit, had been aiming at. We will not here contest the question of priority of invention. It has been fought out many a time; and we believe that no one will grudge Dr. OTTO the benefits and comfort which his work and exertions brought him. He was an honorable man, esteemed by all who knew him, and his invention was not a lucky hit. He was not trained as an engineer, but he made himself one by hard work and study; and his achievements prove his great theoretical knowledge, mechanical dexterity and fertility of resources.—*Engineering.*

## The League Island Dry Dock.

The timber dry dock at the League Island Navy Yard, at Philadelphia, was officially tested, and two monitors were docked on March 4. This dock was built under an act of Congress of 1888 appropriating $550,000 for this purpose, and the contract was awarded to J. E. Simpson & Co., of New York, for a type of timber dry dock patented by that firm. The contract price was $548,700, and work was commenced on Feb. 23, 1889, and under the contract the dock was to be completed within two years. Civil Engineer R. E. PEARY, U. S. N., was in charge of the improvements at this yard, and Mr. WM. SIMPSON, the junior member of the contracting firm, personally supervised the construction.

The soil on which the dock is founded is alluvial in character for some depth, with firm gravel beneath. A coffer-dam was first built across what was to be the entrance to the dock, and then about 7,500 piles were driven, about 4 ft. apart, to support the bottom and sides. The general dimensions are 500 long, 130 ft. maximum width, and 32 ft. in depth.

The Simpson type of dock has been referred to before in this journal, and is chiefly remarkable for its simplicity, efficiency and comparatively small cost. It may be described in cross section as follows: Immediately on the axis of the dock a transverse row of six or seven piles are driven close together and capped by closely, laid longitudinal, heavy sills. From the center toward the sides this line of piles is continued, with spaces of about 4 ft. between centers; the heads are cut off level with the top of the longitudinal center sills, and a heavy transverse timber is bolted upon them, extending clear across the dock bottom. The heads of these piles are imbedded in concrete, with an inclination toward the center and a general dip toward the pumping wells. This general arrangement is shown in Fig. 1.

The sides are built on an angle of about 45° by driving a row of vertical piles with their heads cut off on this angle and capped by an inclined wall piece with the toe butting against a longitudinal timber at the foot of the slope. The heads of the piles and these wall pieces are imbedded in concrete. The steps or altars are bolted to the inclined timbers in such manner as to give an 8-in. rise to a 10-in. tread, thus insuring a watertight joint of 2 ins. Altars of the dimensions here given would be cut, without waste, from a 10 × 12-in. stick, two altars to each cut (see Fig. 4).

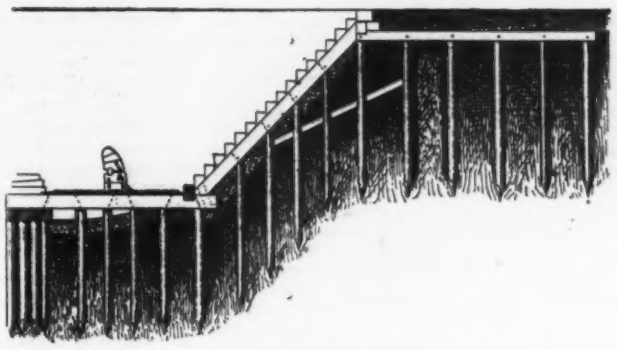


FIG. 1. HALF CROSS-SECTION OF DOCK.

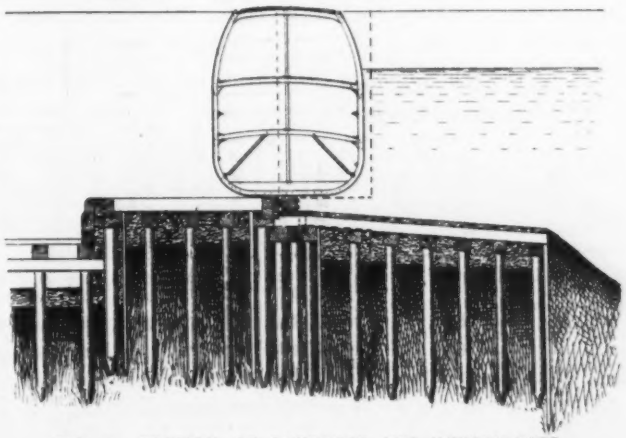


FIG. 2. SECTION OF ENTRANCE AND CAISSON-GATE.

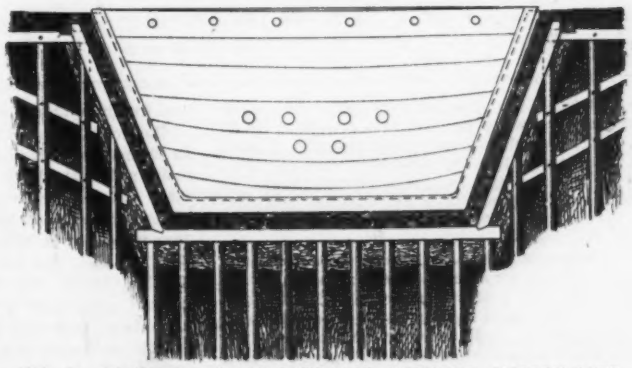


FIG. 3. SECTION ACROSS ENTRANCE SHOWING CAISSON-GATE

The entrance to the dock is closed by a caisson-gate of iron or steel, arranged as shown in Figs. 2 and 3. The general design of the caisson abutments is similar to the dock construction. The keel of the caisson presses against the heavy sill provided for this purpose, and on the outer edge of this sill is a semi-cyclindrical strip of rubber securely fastened, which serves to make a water-tight joint under the water pressure from outside the caisson gate. To prevent the side timbers of the abutments and bottom of gate opening from being attacked by the teredo, they are covered with a coating of asphaltum and gravel, or are otherwise treated for preservation. If the composition named is used, it is put on in a layer about 6 ins. thick and covered by planking to prevent abrasion by the floating gate. By the arrangement here shown the caisson gate need only have buoyancy sufficient to raise it a couple of inches, when it may be floated away.

The caisson gate at the League Island Navy Yard is 88 ft. long on the top, 54 ft. long on the bottom, is 32½ ft. high and 20 ft. wide on top. Running through the gate are eight 20-in. openings, provided with valves, by means of which the dock is filled from the river outside when a ship is to be floated. About 120 tons of iron enter into the construction of this gate, which is really an iron boat of peculiar shape. Water ballast is used, and the tanks in the bottom portion are filled or emptied, in setting or floating the gate, by a special pumping plant carried on the upper deck of the caisson gate.

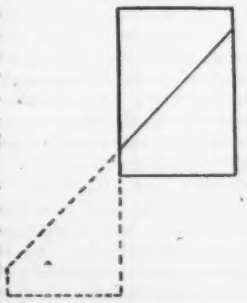


FIG. 4.

This dock will take a vessel of 70 ft. beam, 25 ft. draft and 400 ft. long. For emptying the dock two 42-in. centrifugal pumps, of a contract capacity of 40,000 galls. per minute each, were built by the Southwark Foundry Co., of Philadelphia, and located in a brick pump house on the north side of the dock, and the two conduits, leading from the pumps to the sump in the dock, are each 4 ft. in diameter. The ordinary leakage into the dock is taken care of by an independent pumping plant with a capacity of 2,000 galls. per minute. Three boilers, each 11 ft. long and 13 ft. in diameter, furnish the steam, and can be operated singly or together, as the occasion may demand.

In the official test of March 3 the order was given to flood the dock at 10:15 A. M. This was done by opening the eight 20-in. ports in the caisson gate before described. At 11:20 A. M. the dock was full, with a depth of 22 ft. and about 6,000,000 galls. of water in the dock. At 11:30 the ports were closed, and at 11:33 the pumps were started, the average steam pressure being 65 lbs., and the maximum revolutions 142 per minute. At 12:45, or 72 minutes after the pumps were started, the dock was empty and the engines stopped. The test showed that the contract discharge of the pumps was exceeded, the actual delivery being between 50,000 and 60,000 galls. per minute. The drainage pump, contracted for at 2,000 galls. per minute, actually delivered about 5,000 galls. per minute, with an average of 270 revolutions per minute.

On March 4 the old monitors *Nahant* and *Jason* were docked at one time, and later tests will decide whether there has been any settlement of the dock under their weight. While the levels and measurements necessary to fix this point have not yet been made public, the test was generally very satisfactory. The League Island Navy Yard is the only yard in fresh water in the United States, and the general arrangement will be seen in the inset plan published in ENGINEERING NEWS of Nov. 23, 1889. The two monitors docked had been lying in the fresh water basin at this yard for over 20 years, and the fouling of the bottoms by dirt and weeds was far less than it would have been had these ships being lying in salt water for even one year. There appeared to be very little rust.

## The New Supply Wells and Suction Pipe at Manhattan, Kan.

Manhattan, Kan., built water-works in 1887-8. The supply was taken from the Blue River through an 18-in. tile pipe, laid with open joints to admit water from the surrounding gravel. This arrangement did not prove satisfactory, and early in May, 1890, the superintendent, Mr. G. E. HOPPER, was instructed to sink a gang of 12 wells in the bed of the river, lower the pumps 12 ft., and lay a suction pipe from the wells to the pumps. This work was not of great magnitude, but is interesting in its details, and shows how the water supply in some small towns may be improved without great expense.

Mr. HOPPER's description of the work, as given in his annual report for 1890, is presented below.

After stating that he purchased from the Cook Well Co., of St. Louis, 12 filter tubes, each 4 ins. in diameter and 6 ft. long, Mr. HOPPER continues as follows:

These were located in the bed of the Blue River, about 500 ft. from the pumping station, at a depth of 20 ft. below low water level and distributed over an area 40 × 120 ft. The river bed here consists of 8 ft. of coarse sand, below which is a bed of hard clay about a foot thick. The water is drawn from an 8 ft. layer of clean sand and gravel below this clay layer. The supply is apparently unlimited, and the quality practically filtered Blue River water.

The flow of the wells is collected to the suction pipe by 4-in. to 8 in. wrought iron pipe. All fittings are crosses with unused outlets plugged. The connections are below the present river bed.

A supply of water at a pressure of 90 lbs. per sq. in. was used in sinking the wells, with most satisfactory results. Ten minutes was time enough in which to sink the 4-in. pipe 20 ft., leaving the inside clear for the introduction of the filter tube. Sheet-piling was used to keep sand out of the trenches for laying the connecting pipe; but, the weather being warm and the river very low, no effort was made to keep water pumped down. All threads were made easy, and connections were made below water. The 10-ft. cast-iron suction pipe was laid in three sections, the longest of 180 ft. The former conduit, from the river to the pump-well, was an 18-in. tile, laid in quicksand, at a depth of 4 to 6 ft. below low water level. This tile having been laid without support other than the bed of quicksand, and the joints not being cemented, had settled in places unequally, leaving openings through which the pipe had filled over half full of sand and mud. An opening 16 ft. long was made in this tile near the middle. The 10-in. pipe was shoved either way from there through the tile. Each joint was calked as laid, with lead cast into bars. The pipe was laid with the ends open, and a stream of water was kept running through, which partly removed the sand and mud from the tile; but, on account of the mud settling about the pipe, and the crooked and uneven condition of the tile, it required the combined power of three heavy jack-screws to move the pipe the

last 30 ft. on the 180 ft. section. The third section was laid from the open river end of the tile to the manhole on river bank.

The largest clear opening found, through which sand could work into the tile, measured 1⅜ ins. wide at the widest part. In was on account of openings of this sort, supposed to exist, that the laying of the cast pipe was undertaken. This pipe now connects the wells directly to the pumps.

The pump-pit, located inside the engine house, is 15 ft. wide and about the same average length, with a tunnel level with the floor of pit at bottom, through which the suction and discharge pipes pass beyond the walls of the building The floor of this pit was 12 ft. below the floor of the building; it is now 24 ft. below. One pump was kept constantly in operation while the foundation of the other was lowered the 12 ft. The old wall of the pit was not disturbed, but the new wall—of ashlar, 2 to 3 ft. thick, laid in cement—was built beneath it in sections. No settling of the old wall can be observed. The pumps now stand 8 ft. above l w-water level.

The total cost of the work, excluding the suction-pipe, was $2,447.

Descriptions like the above might, with profit, be inserted in annual reports much oftener than is the case. As it is, many of the smaller works print no report whatever, and so cannot exchange for the reports of other works and thus gain the benefits to be derived from a comparison of methods. The plea of economy is not a sufficient excuse for not publishing an annual report, as the report from which the above extract is taken is full and valuable in every particular, yet is printed on a sheet 5½ × 11 ins., both sides being used.

## Methods of Railway Car Lighting.*

(*Concluded from page 235.*)

AMOUNT OF LIGHT REQUIRED.

The following are enumerated as the requisites for satisfactory car lighting:

1. The headlinings in cars should be light in color and warm in tone; the surface should not be of such a high polish as to reflect light locally in a manner unplea ant to the eyes. The numberless mirrors often added for decorative effect are generally a nuisance.

2. The lamps should be placed in such a position that passengers may readily screen their eyes from direct view of the flames of light. This condition demands that lamps be placed high.

3. Good general illumination demands a large number of comparatively feeble centers of light, rather than intense concentration in a few lamps.

4. Economy of light demands sufficient general illumination with brilliant local lighting in positions near where the light is to be used for continuous application, as in reading. This condition is difficult to fulfill without infringing the second, except in the electric lighting system. An attempt, and we think a successful one, to supply this requisite may be found in the sleeping cars of the St. Paul road, where additional lights have been placed in the berths in such a manner that while they are in a position close to the object to be illuminated, they are also perfectly under the control of the passenger, the rays of light being shielded from his direct vision and that of his neighbors.

Best modern practice seems to establish the following:

For 50-ft. passenger cars, satisfactory illumination, 150 candles of light in the body; for brilliant illumination, 200 candles. For sleeping cars, in the 40 ft. of main body, satisfactory illumination, 200 candles; brilliant, 240 candles. All the foregoing in overhead sources of light. To fulfill the third requisite, I recommend that in electric systems, the light be uniformly distributed from equally spaced foci, each having a maximum intensity of 16 candles, and that in other systems no single focus shall have a greater intensity than 30 candles; that in case of oil lamps, where convenience and first cost so demand, these foci be equally spaced in groups of two; that in other combustion systems each focus be single and equally spaced.

THE QUESTION OF SAFETY.

The author considers the popular opinion that the "deadly oil lamp" must go, along with the "deadly car stove," to be a delusion. The oil formerly used in car lamps undoubtedly was highly dangerous; but the oil used to-day is a heavy fluid, very different from the kerosene in general use. It may be heated beyond the temperature of boiling water without giving off vapor; and the flame is very sensitive to draft or jar, so that any accident which would wreck the lamp would be certain to extinguish the flame. As for the danger of the flame coming in contact with the car woodwork, this is common to all flame systems of lighting. The defect peculiar to oil lighting is that the spilling of oil on cushions or woodwork may add fuel to the flames in case of an accident, if *other* fire is in the car; but this fire has properly no place in a car, and, from present prospects, need no longer be counted as a source of danger.

The author discusses the question of danger in other systems as follows:

As for the other systems of flame lighting, represented by the gas and carburetted air, the most we can say is that the elements of danger have been reduced to a minimum by careful attention in details. In the Pintsch system, explosion of a gas cylinder by overpressure or defective material is a possibility, and in such case would probably result in damage to the car sufficient to cause injury to those in the vicinity. But such contingencies, in face of the vastly greater damages attending the pursuit of the ordinary routine of existence, need not cause much uneasiness. Spontaneous explosion of gases is an impossibility, without the mixture of the proper quantity of air and subsequent ignition in a confined space. In case of a wreck the tanks of gas, if distributed at all, would be swept from their fastenings, while the contents would harmlessly escape. As to the gasoline or "Frost" system, the same remarks would apply in speaking of the explosive character of the lighting fluid. The chief danger of this latter system is, however, in handling the gasoline. This substance is extremely inflammable at ordinary temperature, it being difficult to prevent its escape from packages in which it is stored. A prominent road using the system states that 18% of the gasoline evaporates from close wooden packages when standing two months in the oil house. Under these circumstances, its general use at many points on a large system, by necessarily ignorant men, cannot but be looked upon as a grave source of danger to life and property, and one which would require modification of the stringent oil inspection laws of many states before becoming legal.

As for the electric system, the danger of fire to the car, although remote, is not an impossibility; imperfect wiring, accidental cross contacts, or meddling interference, may cause intense local heating and fire to woodwork. Such contingency is made, however, very remote by the system of safety fuses adopted in the wiring; and even if fire were started as above, its spread will be slow, allowing time for passengers to escape.

COMPARATIVE COST OF CAR LIGHTING SYSTEMS.
(Figures Based on Service for One 50-ft. Passenger Coach lit with 150 Candle-Power.)

| System. | No. of burners. Main body. | No. of burners. Closet. | Candle-power of light. Per burner in body. | Candle-power of light. Total in body. | Candle-power of light. Entire car. | First cost of equipment. | Depreciation and 5% int. on first cost. | Cost per car per hour. Oil. Cents. | Cost per car per hour. Supplies and attendants. Cents. | Cost per car per hour. Total running. Cts. | Cost per can.-power per hour. Cts. | Hours burning without refilling. | Cost of equipment per candle-power. | Price of oil or fuel. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Candles | 4 | 1 | 1 | 4 | 5 | $40.00 | $ 4.00 | 82 | .. | .. | .164 | .. | $8.00 | 9½c. per lb. |
| 2. Colza oil | 12 | 1 | 12 | 144 | 156 | 167.00 | 16.70 | 12.22 | 1.06 | 13.28 | .085 | 14 | 1.07 | 65c. per gal. |
| 3. Mineral oil. (Moehring burners) | 12 | 1 | 12 | 144 | 156 | 167.00 | 16.70 | 1.67 | 1.06 | 2.73 | .018 | 15 | 1.07 | 9 1/8c. per gal. |
| 3. Mineral oil (Duplex burners) | 12 | 1 | 10.5 | 126 | 136½ | 167.00 | 16.70 | 1.21 | 1.06 | 2.27 | .017 | 18 | 1.22 | 9 1/8c. per gal. |
| 3. Mineral oil. (Acme burners | 6 | 1 | 26 | 156 | 168 | 113.00 | 11.30 | 1.94 | 57 | 2.51 | .015 | 13 | 67 | 9 1/8c. per gal. |
| 6. Oil Gas. (Pintsch). | 16 | Moehring 1 | 10 | 160 | 170 | 552.00 | 64.07 | 2.05 | 55 | 2.60 | .015 | 34 | 3.24 | $1.87 per 1,000 cu. ft. |
| 7. Carbureted Air. (Frost). | 4 | 1 | 42 | 168 | 180 | 536.00 | 80.40 | 3.48 | 1.12 | 4.60 | .026 | 43 | 2.98 | 15c. per gal. |
| 8. Electric. Storage and direct current | 9 | 1 | 16 | 144 | 160 | 863.00 | 137.47 | .. | .. | 13.20 | .083 | trip. | 5.40 | |
| 8. Electric. C., M. & St. P. Ry. "direct" | 9 | 1 | 16 | 144 | 160 | 395.40 | 36.35 | .. | .. | 9.83 | .061 | " | 2.47 | |

COST OF THE VARIOUS SYSTEMS.

The accompanying table gives a comparison of the cost of several different systems based on the lighting of a standard 50-passenger coach lit with 150 candle power. In estimating cost of equipment plain but sightly lamps have been provided for. Depreciation is estimated separately from minor repairs, which are allowed for in the column headed "supplies and attendance." The column headed "total running cost" does not include interest and depreciation, but is obtained by adding the two columns preceding it. The cost of equipment per candle power is obtained by dividing the first cost of equipment in column 6 by the total candle power, given in column 5.

The figures for the cost of oil per car per hour and the total cost per candle power hour were obtained by actual experiment in the Chicago, Milwaukee & St. Paul laboratory, as were also the figures for the colza oil system. The figures for different burners using mineral oil are also the result of experiments made by the St. Paul Co.

Figures for the Pintsch system were obtained partly from the Safety Car Heating & Lighting Co. of New York and partly from experience on a prominent road using the system. The first cost of equipment includes each car's proportion of the cost of gas-works figured at $181.75 per car; also two gas-tanks per car. If only one tank is used a saving of $85 per car will be made. Depreciation is taken at 10% on the gas-works and 5% on the car equipment.

For the Frost system the number of burners and first cost were obtained from the company introducing it. The other figures are the result of recent careful experimenting with the system by a railway company. Depreciation is estimated at 10%, and the cost of gasoline per car per hour includes 15% added to the gasoline required for burning to make up the loss in storage and transportation. The "hours burning without refilling" is taken also from experiments on the road referred to, and was maximum burning time with full carbureters and gasoline of 88° gravity. In practice they found that the gravity of the gasoline was considerably reduced by absorption of the lighter products first, and that after a few fillings the heavier oil caused considerable reduction of light after burning a few hours; thus, at the start the candle power was 45, but, at the end of 34 hours burning, reduced to 26.6 in one experiment.

The figures for the electric system are for the one first experimented with on the St. Paul road and for the system now in use. The high first cost of the first system is due to the storage batteries. In the system now in use, the cost of the tender car is figured on the basis of one to each 15½ cars in service. On each system $113 is allowed for auxiliary oil lighting equipment. Depreciation on the first system is taken at 25% for engine, 10% for dynamo, 33⅓% on batteries, and 5% on wiring and oil lamps. On the system now in use, depreciation of tender car and equipment is set at 10%.

To show the details of the cost of the system at present in use on the St. Paul road, the following record is given of one trip in October, 1890:

Train of 10 cars; running time, 11 hours. Load, maximum, 152 lamps; average 87.3 lamps.
Indicated HP. hours, 85.6.
Water, per indicated HP. hour, 57.8 lbs.
Water, per trip for lighting, 4,948 lbs.
Evaporation at boiler pressure, per lb. of coal, 5.7 lbs.
Coal used per trip, 868 lbs.
Lamps, per indicated HP., 10.5.
Coal, per indicated HP. hour, 10 lbs.
Cost of coal per ton, $2.
Cost of coal per HP. hour, 1 ct.

ITEMS OF COST.

| | |
|---|---|
| Attendance | $5.25 |
| Lamp renewals (3 at 40 cts.) | 1.20 |
| Oil and waste | .40 |
| Miscellaneous supplies and repairs | .80 |
| Coal for light | .87 |
| Coal to haul car | 2.00 |
| Total cost per trip | 10.52 |
| Or, per car per hour | 9.54 cts. |

In the summer season, when the heat tender is not in use the total cost per car per hour would be reduced by about 2 cts., or to 7.5 cts.

Mr. GIBBS says, however, that the rather favorable figures now obtained by the St. Paul Co. are due to exceptionally favorable conditions, such as

* A paper by GEO. GIBBS, Mechanical Engineer C., M. & St. P. Ry., before the Western Ry. Club.

excellent distribution of equipment and careful attention to details.

THE VARIOUS SYSTEMS COMPARED.

Mr. GIBBS considers that only four methods of car lighting are really worth careful consideration, viz., heavy mineral oil in lamps, the Pintsch oil gas, the Frost carbureted air and the electric.

*The electric system* in the present state of the art is adapted to special service only. It fills a number of the requirements of a perfect light in a manner which no other light approaches. It is, in fact, a luxury which is duly appreciated by the traveling public. On the other hand, it is at present costly, and requires too much attention to details and too much skilled management to be suited to general use.

Mr. GIBBS comments on the other systems as follows:

*The Frost System.*—I am bound to consider this system still in the process of development. It has many advantages from an outside point of view; it is cleanly, the light is good, each car is perfectly independent of others for its supply of light, and it requires no external gas works. On the other hand, the first cost is excessive, the light is not cheap for running, its quality is not uniform—due to the effect of varying temperature and quality of gasoline—the apparatus is complicated and, while the system may be considered safe to the car itself, I believe the use of gasoline at various points on a large system very questionable.

*The Pintsch System.*—This, in spite of some serious defects, I consider the most feasible and promising attempt in the direction of safety car lighting. It is safe—as safe as any flame method of lighting can be—is cleanly and simple, is cheap in maintenance and running. It is, however, very high in first cost and is not universally applicable, on account of dependence upon gas works. But all main line traffic and many important branch lines can generally be provided for by this system at a moderate cost and, under its rapid extension now taking place, it seems likely that joint gas works can be maintained by different roads at many points to still further reduce the individual outlay. The introduction of the system has been pushed in this country lately with a high degree of success; but there are two points I cannot understand in the business policy of the company: first, why they stick to an uneconomical form of lamp, and, second, why they import from Germany their entire equipment? This last point has rather an important bearing on the question of repairs; unless they have recently changed, the German (Whitworth) system of screw threads was adhered to throughout.

*Oil Lighting by Lamps.*—Many of the requirements of a satisfactory car-lighting system appear to me to be embodied in the present oil system—or might be, with some improvements which are readily attainable. In no system, with the exception of the electric, is it possible to obtain a better or more satisfactory distribution of light, the centers being of moderate intensity; the fuel is safe to handle and may be anywhere obtained without delay; each car is perfectly independent of others; it is cheapest in first cost and maintenance for a given amount of light; it is simple and easily taken care of. On the other hand, it shares with other flame systems the objections of giving out much heat, and the quantity of light is quite irregular and the smell objectionable when not taken care of. The ground of safety appears to be the one generally attacked; I have elsewhere stated my reasons for not believing this objection to have much force. In fact, I believe it is a mistake to abandon the system until a thoroughly better one has been devised—respecting which there is at least a doubt. The possible improvements in this system should have more attention from railway officials and others. For instance, the button form of burners, of which the "Acme" is a good example, appears to solve the problem of sufficient light as satisfactorily as has been done in the other flame systems, and these burners should be substituted for the old uneconomic form.

## The Motions Observed in the Hawkesbury Bridge.*

These motions probably arise from causes of two kinds; internal causes to be ascribed to the construction and the foundation of the piers, and external causes acting upon the piers

The chief external cause is the situation of the bridge at the foot of a very steep gradient of 132 in 5,280, equal to 25 in 1,000, or 1 in 40 approximately. All trains coming down this incline, often with double engines, run with the brake on, and the shock and longitudinal thrust which they impart to the bridge is very great in itself, and is further increased by the vibrations. Engines going up try to gain a good start for this gradient, and excercise thus a thrust of unusual intensity in the same direction.

The bridge over the Narva River in Russia, which was under my superintendence in 1874, supplies a perfectly analogous case. This bridge also lies at the foot of a steep gradient, between this gradient and Narva station (Fig. 1). The bridge had wandered toward the station by about 5 ins., and taken the pier with it, when I succeeded in stopping the motion. Several favorable circumstances facilitated my task. The bridge lies between rocky banks, the rock having been blasted to obtain a firm seat; and the difference between day and night temperature there is considerable. I had wedges driven in between the iron structure and the rock, and tightened those wedges every night as soon as they got loose. By these means I brought the bridge back to its original position in six days; and the pier was taken back again in this return motion.

Temperature differences and the consequent irregular dilatation of the iron structure furnish another "external" cause, especially with direct sunshine. The sun rays never reach the whole structure; part of it will be in the shade. If the track lies on the top of the bridge, the iron will temporarily be in the shade of the flooring, even in brightest sunshine, and heating and expansion will take place sometimes on the one, sometimes on the other side. The whole of one side may be warm, while the other is covered with ice and hoar frost, or remains wet and cold. Even during night time, the one side may be dry, the other wet, according to the intensity of the previous heating, rain, &c.

It is clear that a theoretically correct construction will thus be exposed to constant modifications. The consequent irregulatities of shape, or of stresses in cases where the construction would not permit such irregularities of form fully to manifest themselves, are of greater importance than might be thought. Assuming a girder of 100 meters length and a difference of temperature between different parts of the iron structure of 40° Centigrade (72° Fahr.), the difference of dilatation would amount to 0.05 meter (2 ins.). This displacement of 2 ins. in the seat of the bridge would produce, or tend to produce, at the periphery of the piers of 48 ft. width of the Hawkesbury Bridge, a displacement of from 8 ins. to 10 ins.

FIG. 1.

The rollers between the pier and superstructure cannot perform their duty to theoretical perfection. When the iron structure undergoes change of form, the axes of the rollers will no longer remain strictly parallel to one another, and the rolling motion will pass into a sliding motion, straining the pier. Moreover, dust, sand, occasionally even bits of iron, as my experience teaches me, collect under the rollers; one of the rollers of the Narva Bridge I found entirely cracked. It is further notorious that rollers under long girders will deviate from their normal position after some time, when they can no longer act normally. An incessant control of these parts is as difficult and hence as rare as it is to keep these parts perfectly clean; and the adjustment of the rollers is a very troublesome affair, not often attempted. Every irregularity of form in the girder, resulting from differences of temperature, affects the rollers; the single effects are very minute indeed, but they accumulate as the changes occur several times during the day.

As regards the internal causes of motions such as observed, due to the construction of the piers, I submit the following considerations: The piers or their chief portions stand in mud, upon a basis of sand or of rock. At any rate, the subsoil has been regarded as sufficiently firm. But this is a grave question.

How can we bring up from such a depth the real subsoil—I do not mean what we bring up by means of dredging, boring, etc., loosened and impregnated with water—and how shall we judge of its permanent strength if the soil be not rock? Nobody can answer these questions in the case of an open surface soil, not to speak of a subsoil 200 ft. under water. What the dredging engines send up is so modified that it can convey no idea of the actual composition and stratification of the subsoil. In its long passage the water has loosened the material, impregnated it and washed out fine sand and mud particles present. What we see of a sand soil under a caisson is just as deceiving, since the high air pressure has forced the water out of the sand and essentially changed its appearance and character.

But even if we succeed in bringing up big lumps of the actual subsoil, we should have no guarantee; for our knowledge of foundations, and not only of such as sand, clay, mud, is still imperfect and superficial to an inconceivable degree. A soil may stand a test well and appear firm, even brittle like glass, and yet be as incapable of resisting any permanent pressure as asphalt and pitch, and ooze out if there is a possibility. A good many combinations of clay and sand of similar properties occur under water.

We may have worse cases even. A wet sand may appear of great bearing strength during the test, and may, indeed, possess the same permanently as long as the load remains steady and uniform. But that same soil will become quite unfit if the load varies, especially when we have strong vibrations in addition as we have unquestionably in an unusual degree in the Hawkesbury Bridge. Any child playing upon the beach illustrates this fact. As long as the child stands still the wet sand is firm enough to bear it; splashing and stamping soon make it sink into the sand.

Our testing laboratories have to do a great deal more to supply us with really useful and practical information about our building materials. We are deplorably ignorant even as regards so important a material as iron. We have long lists—and they differ often enough—of tests on pressure, breaking and tensile strength, resistance to blow, torsion, etc., but we know little or nothing about those figures, for they vary with the various temperatures between the solid and the liquid state, and with various kind of strain, the rapidity and suddenness of pressure or pull and their duration and uniformity. A strong pressure, applied quickly and directly, has an effect totally different from that of a gradually increasing pressure: the effect in the former instance approaches more and more that of a blow, into which it passes finally. A well-known simple experiment demonstrates this clearly. A ball kneaded out of new bread cannot permanently be deformed by a rapid blow, and proves as elastic as caoutchouc. By means of slow pressure, however, we may "knead" the ball into any shape, which it will retain. Iron, like other metals and many different materials, inclusive of water and ice, presents the most varied cohesion phenomena—among others also a pasty consistency—in the intermediate stages between the solid, liquid or molten and gaseous state; and the strains to which "working" materials are exposed are also of so varied a kind that a further study of these problems is most desirable. High speed trains and engines cause rapid shocks. During building and erection we have slow, steady pressure.

The usual data about breaking strength are not infrequently useless for practical purposes, as they do not distinguish whether the surface under pressure was as large as, or greater or smaller than, the pressing surface. Yet this point is of paramount importance, particularly as regards building materials and soil. Thus, for instance, sand is considered an excellent foundation, provided the sand be firm and confined; under that supposition water would be equally firm, if not firmer. It is manifest that there is compression strength in a sand only as long as the pressing and the compressed surface are of equal area; if the pressing surface become materially smaller, the resistance co-efficient of the sand diminishes. Similar considerations apply to other materials. We have always to distinguish whether they are confined by the same or by other materials. In masonry the mortar is under pressure and literally confined by the bricks—a proof by the way, of the irrationality of cement tests by means of pull instead of pressure.

Assuming that the piers of the Hawkesbury Bridge stand upon firm sand (*Engineer*, March 7, 1890), we should have no guarantee that the foundation will prove *permanently* firm. It is, however, very doubtful that the piers rest upon a sand such as the preliminary tests indicated, and as gained during the sinking of the foundations, as I will show. The sand is now, immediately under the piers and close to the piers, not in the same state as it was before the sinking, and all the less so because the sinking offered considerable difficulties and because the piers are strongly splayed out.

It is well known that even for caissons considerably shorter than those of the Hawkesbury Bridge, the bulk of soil to be removed is much larger than the volume of the caisson. I had to remove a fourfold volume, when sinking conical cylinders in the Rokitno marshes in Russia, where I met a great number of oak trunks up to 3 ft. thick, lying inclined at a great depth. The mass to be removed by dredging comes, of course, from the ground around the caisson; and I have convinced myself that the excavation forms a conical hollow. A hammer which had been dropped outside the cylinder was afterward brought up from the inside. As a rule it is plainly visible that the ground gives way and that the overlying mud is carried into the hollow washed out by the water. I have even found live fish within the cylinder.

The soil underneath and by the side of the caissons of the Hawkesbury Bridge is, therefore, mud, or sand strongly impregnated with mud; this seems all the more clear as the operations were very difficult and the cutting edges strongly divergent.

The engineers in charge of the operation will know what they brought up last, and will have taken into consideration what mud and fine sand would have been washed out of the buckets in passing through 200 ft. of water, and that they hence did not examine the actual subsoil. Let us grant that the buckets brought up at the last a pure sand and a firm sand. But the soil would not remain as it appeared during the operations. Immediately after stopping dredging operations the soil inside the caisson, and particularly any fine sand and mud present, would swell when the depth is so considerable. Several days must pass before the dredging engines could be replaced by the plant for laying the concrete. Even a few hours, however, would suffice to permit of an infiltra-

* By W. EWALD, Engineer, Hamburg, in *Engineering* of Feb. 6, 1891.

tion of the soil; and as the laying of the concrete proceeds from the center toward the edges, the outer parts would in any case be exposed to an infiltration for a longer period.

The sand and mud may have the same and even a higher specific gravity than the piers and the pressure exerted by the weighty piers be relatively small, so that a pasty layer of mud may exist between the piers and the hard subsoil without being forced out laterally. Any increased eccentric pressure or push occasioned by trains crossing the bridge would, under these circumstances, be able to displace the piers.

The case becomes still worse if we assume that the piers stand, not upon sand or mud, but upon rock. Probably this is so, since the report specifies that vertical disturbances have not been observed. We need not, in this case, make the improbable hypothesis that the piers rest upon rock edges. Nobody will expect that creation should have supplied specially horizontal strata as bases for the piers in this instance, and that the cutting edges should be based as evenly as can be achieved, with considerable trouble, by employment of air pressure caissons. We may, on the contrary, assume that the strata are inclined, and that they actually support the piers at one point only (Fig. 3). It will barely have been possible, further, perfectly to level the rock stratum at so great a depth, even with the help of grab dredgers. Under such conditions the piers would be safe against vertical vibrations, but all the more exposed to lateral vacillations. Another circumstance tends to increase this liability.

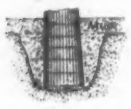


FIG. 2.

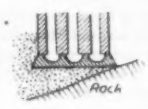



FIG. 3.

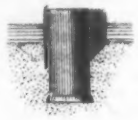


FIG. 4.

The concrete was to be applied directly and uniformly immediately after sinking the cassions. But one cannot clear the surface of sand with three shafts and one dredger, supposing even the work to be flat, nor can the buckets get into the angles. Presumably they did not work at this depth in front of the cutting edges, but behind. It is also doubtful in view of the tendency of the pier to cant, whether the dredging extended everywhere down to the rock. If this should have succeeded, however, mud and other soil would have penetrated into the shafts as soon as the dredgers were stopped, and before the concrete could cover the whole surface, as I have already pointed out.

Thus the concrete does not rest upon rock, but upon the mud, and unfortunately not with the fine plane surface of the diagrams, but with knobs and lumps. No practical man would guarantee a perfectly uniform layer of concrete working at so great a depth from three shafts toward all the angles. If finally the soil which filled the empty space around the shoe has yielded we should have a concrete standing on irregular knobs and a pier imbedded in a yielding mud, the worst possible combination for favoring a pendulum motion of the pier.

My conclusions are the following:

1. The piers of the Hawkesbury Bridge are exposed, owing to the situation of the bridge at the foot of a steep gradient, to a thrust of unusual strength.

2. The changes of form of the girders, arising from dilatation, and the consequent irregular positions of the rollers, subject the heads of the pier to both thrust and pressure.

3. The great depth of the piers excluded hydraulic work; the piers could hence not be based sufficiently firm and uniformly to enable them to resist the strains mentioned under numbers 1 and 2.

4. The sinking was troublesome, occupied a long time, and the soil around has been disturbed to a degree that it will not soon settle again firmly, and perhaps never will settle, considering that the piers may be entirely surrounded by mud.

What is to be done?

I can hardly offer a positive opinion, since I am not sufficiently acquainted with the details. Yet the idea would recommend itself to sink stones and heavy slags around the piers in order to stop the movements. If any permanent canting should have manifested itself, wedges weighted with rails, which could easily be removed again afterward, might be inserted on the one side and their action be supported by forcing water under high pressure through pipes reaching down to a good depth on the other side. By these means the piers might be righted again. One might further try to harden the subsoil around the piers by means of cement, as has recently been done in Germany. A heavy loading of the piers at certain parts, or uniformly all around, might also help to compress the subsoil and impart greater stability to the piers; the piers might in that case have to be carried a little higher, not to disturb the level of the superstructure. To avoid similar disturbances, I should recommend:

1. To employ caissons of a more suitable contour, circular or square.

2. Always to construct piers, even when sunk to a great depth, in a manner so as to permit of their being *inspected* after completion of the work in all parts down to the bottom; if possible by means of air pressure; and to permit further af their being raised again entirely should the necessity arise.

I cannot here explain how this might be accomplished; but I shall be pleased to communicate with anybody interested.

3. To fill the caissons with a material as heavy as possible, even to employ pig iron instead of stones for the concrete. The additional expenses would not be so considerable and would be compensated for bp the quicker and easier way of sinking.

The lower the centre of gravity of the caisson, the better it will "go," and the less will be the dislocation of the surrounding soil.

The proprietors of the bridge have had the courage to entrust the work to an American firm. Foundation work more than any other is a matter of confidence; and it must indeed be left to the proprietors where to place their confidence.

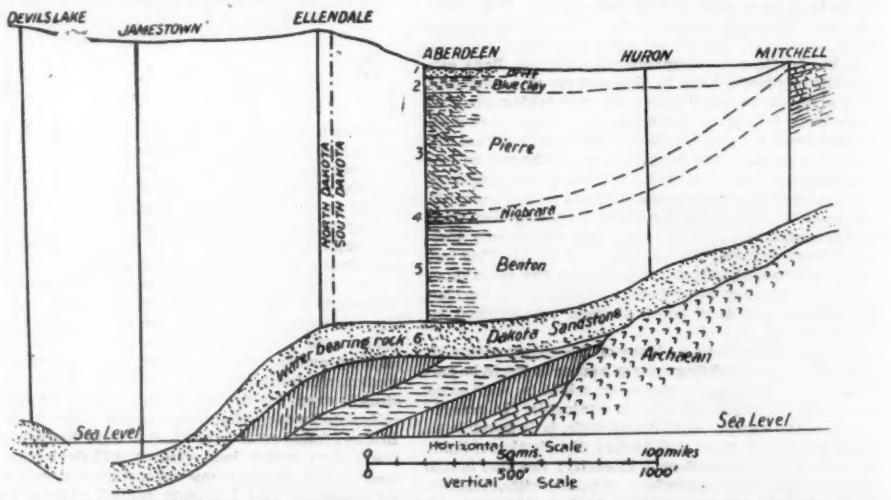
## Artesian Well Practice in the Western United States.

(*Continued from p. 172.*)

II.

NORTH AND SOUTH DAKOTA.

The well of the Dakotas are the most notable in the United States, if not in the world, and for this reason deserve independent and somewhat extended notice. The most remarkable wells are in the James River basin, extending through the two Dakotas in a nearly north and south direction. The relation of water-bearing rock to the surface in this basin is shown by the accompanying section, which extends from Devil's Lake, N. Dak., to Mitchell, S. Dak., a distance of 312 miles. The section is taken on a line S., 10° E., and was drawn by Prof. G. E. CULVER to accompany his portion of the Government report on artesian wells upon which these articles are based. It may be well to add, for the information of those desiring further details than are given below regarding the geology of the Dakotas, that such details can be found in Prof. CULVER'S section of the report, which treats of the geology of the Dakotas and in Prof. G. E. BAILEY'S report on the southwestern part of South Dakota.




PROFILE SHOWING POSITION OF WATER-BEARING ROCK ALONG THE JAMES RIVER BASIN FROM DEVIL'S LAKE, N. DAK., TO MITCHELL, S. DAK.

As shown by the accompanying section, and as noted in our issue of Feb. 27, the high-pressure wells of the Dakotas top the Dakota sandstones. The well at Devil's Lake has a total depth of 1,511 ft.; that at Jamestown, 1,486; Ellendale, 1,087; Aberdeen, S. Dak., 955 ft.; Mitchell, 546; while that at the Santee Agency, Neb., 63 miles south of Mitchell, is 604 ft. in depth, of which 159 ft. is in the Dakota sandstone.

The Aberdeen well penetrated strata as shown below, the numbers corresponding with the numbers on the section:

| | | | |
|---|---|---|---|
| 1. Drift | 36 ft | 6. Dakota sandstone, | |
| 2. Blue clay | 64 " | ing | 60 ft. |
| 3. " shale | 410 " | | |
| 4. Limestone | 20 " | Total depth | 955 ft. |
| 5. Blue shale | 365 " | | |

In the James River basin, N. Dak., there are four flowing wells, with an average flow of 1,150,000 galls. per day, and an average pressure of about 100 lbs. per square inch. They are located at Jamestown, Ellendale, Oakes and Devil's Lake, and the last two have depths of 947 and 1,550 ft. respectively. All are at an altitude of 1,300 ft., or more. By far the larger number of wells in this State are in the Red River basin, or in adjoining counties in the northern part of the State. Most of these wells are shallow and of small diameter. Their depth averages about 250 ft., and their average daily flow appears to be about 30,000 galls. In Trail County alone there are 300 of these wells. The average altitude of the section is about 900 ft.

The wells of North Dakota, or those tabulated in the reports, range from 8 to 2 ins. in diameter and in depth from 1,565 to 113 ft. Details of their size, depth and cost are given below in connection with a similar summary for South Dakota.

The James River basin extends southwards from North into South Dakota, and in it are many wells of high pressure and large flow similar to those already described. In Yankton and Bon Homme counties there are also many wells.

SIZE, DEPTH AND COST OF ARTESIAN WELLS IN NORTH AND SOUTH DAKOTA.

*North Dakota.*

| | | Depth. | | | Cost. | | |
|---|---|---|---|---|---|---|---|
| Size, ins. | No. | Max. | Min. | Av. | Av. | Max. | Min. |
| 8 | 1 | .... | .... | 912 | .... | .... | 4.16 |
| 6 | 2 | 1,565 | 200 | 888 | 6.03 | 6.49 | 2.15 |
| 5 | 1 | .... | .... | 1,087 | .... | .... | 4.04 |
| 3 | 2 | 355 | 304 | 330 | 2.05 | 2.47 | 1.86 |
| 2 | 5 | 316 | 158 | 211 | 1.55 | 2.61 | 1.00 |
| All wells.... | 11 | 1,565 | 158 | 617 | 5.00 | 6.49 | 1.00 |

*South Dakota.*

| | | Depth. | | | Cost. | | |
|---|---|---|---|---|---|---|---|
| Size, ins. | No. | Max. | Min. | Av. | Av. | Max. | Min. |
| 6 | 4 | 1,068 | 546 | 736 | 4.91 | 5.73 | 4.20 |
| 4½ | 2 | 672 | 636 | 654 | 4.13 | 4.25 | 4.00 |
| 4 | 2 | 1,000 | 587 | 794 | 3.82 | 4.00 | 3.50 |
| 3 | 1 | ..... | ... | 665 | 1.50 | .... | .... |
| 2½ | 1 | ..... | ... | 87 | .46 | .... | .... |
| 2 | 42 | 785 | 175 | 322 | .78 | 1.62 | .42 |
| 1½ | 1 | .... | .... | 578 | 2.00 | .... | .... |
| 1 | 2 | 1,139 | 295 | 717 | 2.68 | 3.25 | .50 |
| All wells.... | 55 | 1,139 | 175 | 416 | 2.05 | 5.73 | .42 |

The above table presents in a compact form the maximum, minimum and average depth and cost of 11 wells of various sizes in North Dakota and of 55 in South Dakota. It will be seen that 5 of the 11 wells in the former and 42 of 55 wells in the latter State are 2 ins. in diameter, while in South Dakota there are three additional wells less than 2 ins. in diameter.

The deepest well in the Dakotas, so far as reported, is 1,565 ft. This well is at Hamilton, Pembina Co., N. Dak., and has a daily flow of but 13,120 galls., while it cost $10,150. It is 6 in. in diameter, and is located in the Lower Red River basin. The range of depths in both States, where diameters are given, as shown by the tables, is from 1,565 ft., noted above, to 158 ft. The average depth of the 11 North Dakota wells is 617 ft.

The total depth of the 11 North Dakota wells is 5,479 ft., their total cost $21,911, and the average cost per foot for the aggregate depth, regardless of size, $4. The range in cost per foot is from $6.49 for a 6-in. well, 1,565 ft. deep, at Hamilton, to $1 or thereabouts, for some of the 2-in. wells.

In South Dakota 55 wells have an aggregate depth of 22,885 ft., an average depth of 416 ft., an aggregate cost of $46,832, and an average cost per foot of combined depth of $2.05. The range in depth in South Dakota is from 1,139 ft. for a 1-in. well at Frederick, Brown Co., to 175 ft. for a 2-in. well at Beaver, Miner Co. The range in price is from $5.73 for a 6-in. well 546 ft. deep at Mitchell to $0.42 for a 2-in. well 285 ft. deep at White Lake.

Of course the cost of wells varies with the strata pierced, but the data necessary to classify cost by strata pierced is not at hand. The figures given present a fair idea of the cost of wells in the two States, and show that if assured of water by boring the farmer can well afford to put down wells to develop a water supply for irrigation, in the Dakotas at least. Coöperation will make possible the sinking of large and deep wells, which in some parts of those States are sure to pay.

## The Metropolitan Underground Ry. Co.'s Tunnel Under the East River.

(WITH INSET.)

We illustrate in our inset of this week the first step in the Metropolitan Underground Railway project for rapid transit in New York, as inaugurated by Mr. AUSTIN CORBIN and his friends, and are indebted to Mr. CHARLES M. JACOBS, M. Inst. C. E., and Chief Engineer for the company, for the plans here used.

These plans show the tunnel under the East River, between Atlantic Ave., in Brooklyn, and Whitehall St., in New York, and the arrangements made for connecting with a comprehensive system of rapid transit for New York and the region across the Harlem.

Before locating this tunnel the bed of the river was thoroughly explored by the diamond drill and the cores brought up show a compact gneiss, that promises little trouble from the infiltration of water. The tunnel, including stations, will be 6,050 ft. long, and will lie wholly is the solid rock, and so graded as to generally conform to the contour of the rock bottom. The dimensions of the tunnel will be 26 ft. wide and 20 ft. high, from the head of rail to the to the crown of the arch, thus permitting its use by the largest cars now made for passenger traffic. Both tunnel and stations will be lined with brick set in cement mortar.

The grade in the tunnel is 1 in 100, in opposite directions, meeting at a point 650 ft. from the New York side of the river and immediately under the lowest point in the rock surface. From this point to the Brooklyn station a drainage heading will be driven leading to the foot of a vertical pumping shaft connected with this station. The tunnel will be ventilated through air shafts immediately below the crown of the tunnel and extending the whole length, and provided with powerful exhaust fans at either end.

The double line of rails laid down in the tunnel will be extended far enough at either end to form a crossover, as shown on the plan, and thus provide for the circulation of trains between the two stations. The stations and these crossovers are set out level.

The stations, as planned, are 322 ft. long, 60 ft. wide and 30 ft. high in the central part. The shaft connecting this station with the ground above is 72 ft. by 17 ft., though the emergency stairway and the provision for pumps and ventilating shaft will alter slightly the plan shown. On the New York side the bottom of the shaft will be 90 ft. below the street level and 118 ft. below on the Brooklyn side.

Each shaft will contain six elevators, of a capacity of 56 passengers each, and an emergency staircase of stone, 5 ft. wide and with landings every 8 ft. in its height. Besides these there will be provisions made in this shaft for ventilating and pumping, as before mentioned. The elevators will be operated by hydraulic power at a speed of 400 ft. per minute. These elevators land at the bottom in the center of the station platforms, and double sliding doors, on each side of the cage, open out on the departure and arrival platforms. On the New York side three of the elevators ascend to the level of the elevated railway system, so that no time need be lost in transfer. The time allowed for the journey between the New York and Brooklyn stations is four minutes, including in this period the entering of the elevator, descent to train and crossing of the river and the ascent to the street level on the other side. The train and elevator capacity is thus 12,000 passengers per hour.

The motive power proposed is electricity, with a motor in each car, or a motor to a train of cars, as may be later decided upon. The permanent way will include 90-lb. rails and the heaviest creosoted oak ties on stone ballast. The speed arranged for is 30 miles per hour. All parts of the tunnel, stations, elevators and cars will be lighted by electricity.

The entire project seems to be most carefully worked out and every provision made for both the safety and comfort of passengers. We understand that arrangements are practically completed for commencing work at an early date. An inspection of the general elevation shows that the approaches are arranged for continuing the tunnel at either end so as to cover rapid transit routes in both cities, should this be decided upon hereafter. Mr. CORBIN'S project includes a similar tunnel under the North River, starting practically from the end of the East River tunnel. Borings carefully made on the proposed line of the North River tunnel show favorable ground, mostly rock. In a later issue some further information will be given regarding the possible extensions of this East River tunnel.

## Caissons or Foundations Formed by Cementing Loose Materials.

The method of forming a cemented coffer-dam or caisson, and of strengthening foundations, described in a paper by Mr. ROBERT L. HARRIS, read before the American Society of Civil Engineers and abstracted in our last issue, seems to be an improvement of some promise for a certain class of difficult foundation work, and we therefore supplement the details already given by the following drawings and further description abstracted from the patent specifications. The general idea of the device is to inject fluid cement between or among materials already in place, so as to cement them together into a solid mass. Holes are made in the material, in which a pipe is placed, through which is forced the cement in a liquid or semi-liquid state and allowed to accrete. The operation is carried out at each hole in succession and then repeated until the voids are filled by successive accretions, and by a series of operations at different levels a complete monolith of concrete is eventually formed in the loose materials. In this way caissons may be formed in loose materials, which can then be excavated to allow masonry, rammed concrete, etc., to be built inside the caisson; or the method may be used to consolidate material for tunnels, shafts, and other subterranean work. Fig. 1 shows the method applied to the consolidation of a defective foundation of loose rubble. Holes are made in the masonry and rubble for the reception of pipes *a a*, through which may be forced a jet of water to wash away any deposit of mud, etc., before the cement is pumped in. If the material is sufficiently open, holes in the masonry may not be necessary. Fig. 2 shows the method applied to the formation of a caisson around a pier foundation, by injecting cement through the pipes *a a*. When the floor and sides are of sufficient thickness, the material within may be excavated and replaced by masonry or concrete. The cement may be mixed with or without sand according to the material to be dealt with. The cement should be applied in small quantities, otherwise it is liable to be carried away by the water. It should be kept well agitated before delivery to the pump, so as to maintain uniformity in the mixture and prevent clogging.

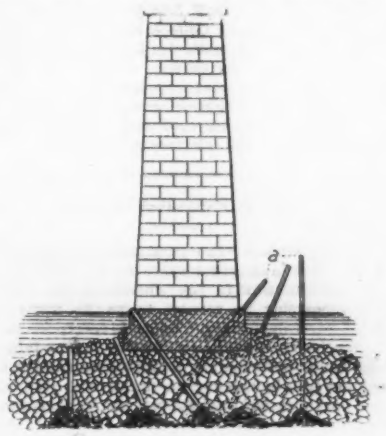



FIG. 1. Cementing Rubble Foundation.

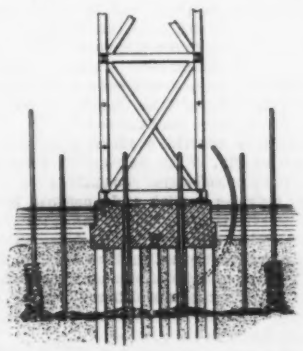


FIG. 2. Forming a Caisson Around Pier Foundation.

## Irish Channel Tunnel Schemes.

The Irish Channel tunnel scheme was lately discussed before the Society of Arts by Sir ROPER LETHBRIDGE. In his paper the four principal tunnel schemes and one plan for a submarine bridge were described. Mr. MAXTON proposes a tube of mild steel built in 400-ft. sections, closed at the ends by temporary bulkheads, floated out to site and connected by suitable appliances. This structure was to be held in place by chains and anchors, and supported at 60 ft. below the surface by its own buoyancy. This project was not favorably considered, as the currents would subject the tube to racking strains; if the cables should fail the tube would also be liable to destruction, and, as the whole work would be submerged, it would be difficult to examine it.

Sir ROPER thought that a tunnel was the only feasible plan. The soil to be penetrated is compact marl, red sandstone and rocks of the Lower Silurian formation. A gorge, 900 ft. deep, runs down the strait as far as Wigtonshire, but Mr. BARTON in his scheme avoided this by curving his tunnel around the end of this depression. His tunnel would be 33 to 34 miles long, with 24½ miles under water. The estimate of cost is about $50,000,000, and 10 years is given as the time required. The gist of the whole paper and the discussion that followed was that private capital could not undertake the work; a government guarantee was necessary.

## Railway Building in China.

The London *Truth* says that in many respects the Chinese are a most rational and practical race. Here is a case in point. During a recent anti-foreign-devil riot at some place between Tong tu and Kaiping, the mob, by way of emphasizing it patriotic sentiments, destroyed a good length of the railway that has recently been carried through the district. The local mandarin—a Chinese Ruskinite apparently—instead of using the forces under him to quell the riot sent his soldiers to assist in the pious work. The embankments were leveled for some distance, and the rails thrown into the river, and an attempt was made to destroy the bridges. Mr. KINDER, the head engineer of the line, laid the state of the case before the Toatoi of Tientsin, who is the head director of the undertaking. The Toatoi sent for the mandarin, and addressed him thus: "To please yourself and your friends you have destroyed the railway track. To please me you will put it back just as it was before. If, one month from to-day the trains are not running the same as before, you lose your head and your family and ancestors are disgraced."

"Mr. KINDER estimates the damage and loss by non-running of trains at 50,000 taels (about £12,500), which sum you will have to pay out of your own funds to the company. For labor, all your officials, soldiers, and the townsfolk will work as you direct, receiving no money for their labor, and all salaries are stopped until the repairs are complete. I shall appoint a board of punishment to return with you, with power to torture and imprison any one who makes the least disturbance or trouble." The mandarin begged for mercy on the plea that, as the the country was all under water he could not possibly get mud and stones wherewith to build the embankments,

The Taotoi saw the force of this plea, and said he would give him a chance. He could pull down any of his forts he liked in order to provide material for the repair of the railway, and he would give him three months after the railway was completed to rebuild his forts at his (the mandarin's) own expense. In rather under three weeks the trains were running again, and they are now rebuilding the forts. How long would it have taken to bring about the same results in England?

## Passenger Traffic in London and New York.

As showing the increase in travel in London since 1864 a correspondent of the New York *Times* gives the following figures: In the year named the public conveyances then in existence carried 53,000,000 passengers, or about 18 trips per head of the then population of London. In 1874, with increased facilities, the total of passengers was 155,000,000, or 45 trips per head. In 1884, after tram lines were introduced, the total rose to 308,000,000, or 77 trips per head of population. During these 20 years the population had increased 36%, the average number of journeys per head 330% and the general passenger traffic 500%. We have no figures handy for 1864, but in 1886 the population of London was 4,149,533; on Sept. 27, 1890, it was 4,421,661.

Contrasting this growth of traffic with the similar growth in New York, we find that in 1884 the New York total of passengers was 272,000,000, with a population of about 1,300,000, an average of 210 trips per head of population. In 1889 the total of travel was 397,000,000, with 1,700,000 population, or 233 trips per head of population. In a late address on under ground rapid transit Mr. AUSTIN CORBIN estimates that in five years the movement of passengers over the New York lines of travel would equal 580,000,000, provided that these lines could furnish the facilities, a proviso that can be best answered by those using the present lines of travel.

## International Niagara Commission.

The Cataract Construction Company, says *Industries*, having invited various firms to send in projects for the utilization of about 125,000 HP. at Niagara, and its distribution, partly to an industrial district in the neighborhood of the Falls, and partly to the town of Buffalo, N. Y., appointed an International Commission to adjudicate on the plans sent in. This Commission consisted of Sir WILLIAM THOMSON, F. R. S., President; Dr. COLEMAN SELLERS, Professor of Engineering Practice at the Stevens Institute of Technology, Hoboken, N. J.; Prof. E. MASCART, Membre de l'Institut, Paris, and Directeur du Bureau Central Météorologique; Col. TH. TURRETTINI, Directeur des Travaux d'Utilization des Forces Motrices du Rhone á Genève. After a careful examination of a large number of projects sent in, in accordance with the letter of invitation of the Cataract Company, the Commission have awarded the following prizes: Projects combining the development of power and its distribution—First prize: Not awarded. One second prize: To the project of Messrs. Faesch & Piccard, Geneva, and Messrs. Cuenod, Sautter & Co., Geneva. Four third prizes: To the projects of Mr. A. Hillairet and Mr. Bouvier, Paris; Mr. Victor Popp, Paris, and Prof. Riedler, Berlin; Prof. L. Vigreux and Mr. L. Levy, Paris; the Pelton Water Wheel Co., San Francisco, Cal., and Norwalk Iron Works Co., South Norwalk, Conn. Projects for the hydraulic development of the power—First prize: To the project of Messrs. Escher, Wyss & Co., Zurich. Two second prizes: To the projects of Messrs. Ganz & Co., Budapest; Prof. A. Lupton, Leeds, and Mr. J. Sturgeon. Projects for the distribution of the power—No prize awarded.

## PERSONALS.

Mr. GEORGE H. GRAHAM, Architect, of Plainfield, N. J., died recently.

Mr. WM. A. GOODWIN has been elected City Engineer of Portland, Me.

Mr. W. H. BLISS, Vice-President of the St. Paul & Duluth R. R. Co., has resigned.

Mr. FRANK A. MERRILL, of Concord, N. H., has been appointed Chief Engineer of the Concord & Montreal R. R.

Mr. GEORGE T. JARVIS, Superintendent of the Ohio division of the Baltimore & Ohio R. R., has resigned.

Mr. WALTER G. FOX, formerly with the Norfolk & Western R. R., is now Assistant Engineer on the Hudson River Tunnel, with headquarters at 35 Broadway, New York City.

Mr. CYRUS BUCKLAND, who patented a number of devices in connection with gun making, which have been adopted at the national armory at Springfield, Mass., died recently.

Col. ROBERT CRANE, President of the Delaware River & Lancaster R. R. Co., died at Philadelphia, Pa., last week.

Mr. JONATHAN SCOVILLE, of the car-wheel manufacturing firm of J. & C. N. Scoville, Buffalo, N. Y., died last week.

Mr. WALKER A. HASKELL, Vice-President of the New York & New England R. R. Co., died at Buffalo, N. Y., March 8.

Mr. GEORGE N. MILLER, a Director of the New York, New Haven & Hartford R. R. Co., died in New York, March 10.

Mr. E. T. LITTELL, President of the New York Chapter of the American Institute of Architects, died in New York last week.

Mr. AUGUST BELMONT has been elected Chairman of the Louisville & Nashville R. R. Co. Mr. MILTON H. SMITH, Vice-President, has been elected President.

Mr. J. F. HOLLOWAY, Past President of the American Society of Mechanical Engineers, lectured recently at Sibley College, Ithaca, N. Y., on "Some Phases in the Romance of Engineering."

Mr. NOYES SPICER has been elected Treasurer and Auditor of the Danville & East Tennessee R. R. Co., with office at Norfolk, Va., vice Mr. H. A. HITCHCOCK, resigned. Mr. HITCHCOCK will retain the office of Purchasing Agent, and will have charge of all matters pertaining to the right of way.

Mr. M. LEWINSON and Mr. GEORGE A. JUST have formed a partnership as consulting engineers and contractors, under the firm name of Lewinson & Just, with offices at 90 Nassau St., New York City. They are prepared to execute iron work from architects' plans and to submit designs for all classes of structures in iron and steel.

Prof. JAMES MADISON has presented the testing laboratory of Lafayette College, Easton, Pa., with an Olsen autographic automatic testing machine of 50 tons capacity, arranged for tension, compression and transverse testing; a 1-ton cement testing machine; a full outfit of appliances for testing rock, cement and mortar; a small machine for testing wire, cord and cloth, and a Henning elongation meter, with micrometer callipers.

## NEW PUBLICATIONS.

*March Magazines.*—The technical article of most real interest, albeit in the strict sense hardly technical, is one by Senator SHERMAN in the *Forum*, on the Nicaragua Canal, rehearsing in earnest terms the many reasons why the government should take this enterprise under its wing, for the triple purpose of keeping it from falling into foreign hands, ensuring its prompt construction, and insuring low tolls by keeping down its first cost and the rate of profits earned on that cost. Mr. SHERMAN corrects a popular error by emphasizing the fact that the movement for a government guarantee has in no way originated with the canal company, whose probable profits it greatly curtails, and he adds in conclusion a sentence which every American may well read and ponder: "To reject or to neglect the opportunity now offered would leave this enterprise to the chance of failure, or transfer its control to commercial rivals whose interests and fixed policy would lead them to convert a great highway of nations into a dependency more formidable than Gibraltar, and more troublesome than Canada."

The same issue contains a strong plea by the eminent English writer, Mr. W. M. ACWORTH, for continued private ownership of railways. The pith of his argument is a contrast between English and American private management and Continental public management; an argument undeniably strong upon its face, but which still leaves open the great question: How much of the contrast is really between systems of management, and how much between the management of different races? We cannot but believe that the latter is a very important, if not a dominating factor in the contrast.

The same argument is more briefly but even more forcibly presented in an article by Prof. A. T. HADLEY in the *Atlantic* on "Railway Problems of the Immediate Future." Professor HADLEY, in addition to the stock comparison with Continental practice, contrasts the railways of New South Wales with our own, and draws an unfavorable conclusion therefrom as to the effect of government ownership. This argument is stronger, but we still question whether it is wholly sound, for reasons indicated in part by an article in another column. It is not entirely conclusive to contrast affairs in a small colony and in a great nation. The strongest argument of all, however, is "Let well enough alone." We are doing pretty well as it is. We might do better by a change, but we might do much worse. It is well, therefore, to hasten slowly at least.

The *Popular Science Monthly* contains an article on "The Relative Value of Cements," by Prof. JAMESON and HUBERT REMLEY, which is well worth reading and summarizes some recent experiments which we hope to give more fully later in these columns. An article on "Non-Conductors of Heat," by Prof. J. M. ORDWAY, is also of interest. Though decidedly popular in form it embodies much recent information on this subject.

*Harper's* and the *Century* lack all technical matter this month, unless we may assume that all engineers will be interested in an excellent article in *Harper's* on modern whist, by N. B. TRIST, the inventor of "American leads." *Scribner's* contains nothing more nearly technical than an interesting record of the exploration of Mt. St. Elias, by which it is alleged to have been determined that Mt. St. Elias is 15,350 ft. high, previous records having ranged from 14,970 to 19,500, the last being the record of the U. S. Coast Survey, "obtained for altitude and position by means of open triangles with long sides," which must have been somewhat ill-conditioned if the latest records are trustworthy.

—*Ancient and Modern Lighthouses.* By Major D. P. HEAP, Corps of Engineers, United States Army. Boston, 1889. Ticknor & Co. Square 8vo, pp. 220, 21 full-page illustrations and many smaller ones. $5.

The author of this work, as Secretary of the Lighthouse Board and an engineer officer of ripe experience, was well equipped for the work he has here undertaken, and has evidently made the best use of his opportunities. Commencing with the meager data concerning the ancient lighthouses of Lybians, Cushites, Egyptians, Greeks and Romans, Major HEAP gives in very full detail the history of the principal modern structures of this type in Europe and in America.

In speaking of the Colossus of Rhodes, about which there has been so much controversy, the author says that it may or may not have been used as a lighthouse, and it is doubtful if it stood at the entrance to the harbor and that the largest ships could pass between its legs. The best authorities, however, say that this colossal statue of Apollo was completed 285 B. C.; that it took 15 years to build; and that it was overthrown by an earthquake after standing 56 years. PLINY says it cost 500 talents ($590,000). The ruins remained 900 years, when the statue fell; but in 672 A. D., says the Byzantine chroniclers, one MAUVIAH had it broken to pieces and sold the fragments to a Jew, who carried them off on "a thousand camels." The Tower of Cordouan, located on a rock in the sea, and built under Henry II. of France, is next described; and this is followed by accounts of other famous lighthouses of that period.

The Eddystone light deservedly comes first in the engineering account of modern structures of this class. The lighthouses of WINSTANLEY, RUDYARD and SMEATON are described in detail and illustrated with reproductions of the plates in SMEATON'S history of this work. The account concludes with the fourth lighthouse of 1879-81. The Bell Rock, in the Firth of Forth; the light on Skerryvore, on Brétat, in France, and that of Armen, also in France, are described.

Major HEAP next discusses lighthouses with submarine foundations, or with iron caissons, screw piles, etc. The Minot's Ledge Lighthouse, in Boston Harbor, was the first iron-skeleton structure of this kind built in the United States. It was built by Capt. W. H. SWIFT, U. S. Engineers, in 1848, and was completely carried away in a storm in 1851. The present stone structure was erected under Capt. B. S. ALEXANDER, U. S. Engineers. It was commenced in 1855, under conditions making construction even more difficult than at Eddystone, and the light was first exhibited in November, 1860. It cost $300,000.

The lighthouses on the Atlantic coast of the United States are next taken up in detail, and much interesting matter, technical and historical, is given concerning them. The Rothersand Lighthouse, in the North Sea, is described in full as a type of construction on a sand shoal by the aid of compressed air. The description includes the trials and failures, final success and cost. This is given as the first example of the erection of a lighthouse on a shoal at a long distance from land. The Fourteen Foot Bank Lighthouse, in Delaware Bay, is then described as an American example of caisson foundation on sand, by the pneumatic process. Major HEAP was the engineer of this work, and, as might be expected, the account of this successful work is very full.

Skeleton iron, screw-pile and lighthouses on the Great Lakes take up Chapter XIII, and the characteristics of lighthouses follow in the succeeding chapter. The latter chapter discusses the forms of light, color and distinctive marking of lighthouses. The electric light on the Isle of May, at the mouth of the Firth of Forth, is described as the most powerful of this class in the world. In this light the power of the arc is 12,000 to 16,000 candles with one of the two machines used, and the copper conductors are rods 1 in. in diameter.

Lighthouse administration closes the work, with a sketch of the methods of various notions in this respect. The text entire is most agreeably written, and is technically valuable in bringing into one volume a mass of widely scattered data upon this interesting class of structures. It is full of hints to engineers, and is good reading

for anybody. In fact, it is one of the most readable books of real technical value which we have come across. They are not apt to be read for pleasure only; this one can be.

—*War and the Weather.* EDWARD POWERS. Cloth, 16mo, pp. 202. Published at Delevan, Wis., by the author; $1.

The first edition of this book was published at Chicago in 1871, and attracted considerable attention at that time. It attempted to show that rain could be made to fall by firing heavy guns for a sufficient time, a fact that the author claimed to be conclusively proved by the meteorological conditions observed after every battle. Since that date Mr. POWERS has delivered lectures on the subject in many cities, and the matter has been recently brought into more prominent notice by a bill introduced in Congress by Senator FARWELL providing for a thorough test. Since the subject is often referred to in the daily press, we give the following abstract from the book to show the grounds upon which Mr. POWERS bases his claims:

These circumstances [the breaking of windows or raising the bodies of drowned persons by firing cannon] render not unreasonable the idea that the effect of artillery firing upon a horizontal current of air may be very great. Such a current, being necessarily in exact equilibrium with the air above and below it, would yield to the slightest force, and it may be conceived that the concussion produced by a number of cannon fired simultaneously would cause it to bend upward. Apply the idea to the case of two currents, one above the other and moving in opposite directions, the upper one cold and the lower warm, and both containing as much vapor as their respective temperatures will permit. The effect of heavy concussions often and quickly repeated would be possibly to throw them upward over the spot where the firing takes place, and finally with their own motion to bring them together. A spiral motion would result from their union; larger and larger portions of two currents would become involved in the change: the two bodies of air would become mixed, and the conditions required by the Huttonian theory of rain would be fulfilled.

Such is the theory advanced, but it is to be noted that the author places his main reliance on reports from officers in the late war, which apparently show that rain was produced after the great majority of battles, and bases his arguments for an actual trial of his plan upon recorded observations more than upon theoretical grounds. The statistics regarding the weather before and after battles form a large part of the volume and are certainly a valuable contribution to meteorology, whatever may be the real value of the proposed method of producing rain.

The appropriation asked of Congress is $2,000 and Senator FARWELL has offered to make good any additional expenditure.

—*The Measurement and Division of Water.* By L. G. CARPENTER, Professor of Irrigation Engineering, State Agricultural College, Fort Collins, Colo. Published by the college and free to all interested in agriculture. Paper, 8vo, pp. 37. Illustrations and tables.

This useful work of Prof. CARPENTER treats of the final distribution of water and the prevention of waste in irrigation works. The paper itself is the result of the study of measuring devices used in Colorado and in Italy, and the experience of the latter country is especially described, as best meeting almost similar conditions in Colorado.

There are two classes of measuring devices, different in their object. One is the *divisor*, or dividing box, which gives to each consumer some definite portion of the water flowing in a ditch, and is especially useful in laterals owned in common by two or three neighbors, or in small canals owned by stockholders; the other, *module*, so called by French engineers, and to a limited extent by English engineers, and recommended by the author for adoption in our irrigation vocabulary. In this class a measuring box is used, which gives the consumer a definite quantity of water, as one cubic foot per second. This box must be adjustable, so that in times of scarcity the amount to each consumer may be reduced proportionately as the supply fails in the canal.

Prof. CARPENTER then describes the common *divisors*, which in various places take the form of an L-shaped movable partition, sliding into the main channel from a lateral, with the top of the L up stream in the main. In some cases the water is brought to a state of comparative rest by a weir board—8 ins. high in the Farmers' Union ditch, San Luis Valley—placed across the ditch above the top of the L, with a sharp crest on the up-stream side. The upper end of the partition board forming the upright of the L is sharpened, and as the water falls over the weir it flows away in the respective ditches. The author says that if the water is brought to a complete state of rest, or nearly so, and flows over the weir without lateral contraction, this method gives the most satisfactory results with the divisor class of measuring devices. This plan was used by the Moors in Spain, and has been in use ever since their expulsion, at Elche, in that country. It was used by Hon. B. S. LA GRANGE, at Greeley, Col., as early as 1871.

The *module* class of distributors is next described and discussed, commencing with the Milanese device of SOLDATI, which is practically the same in its principle of operation as the well-known "miner's inch." But the advantage, in both cases, is entirely in favor of those who draw the larger quantity of water. The difference in ratio between the perimeters and the areas of the openings, in different cases, and consequent difference in frictional values, and other causes of variation, render this module inaccurate and unreliable, and one leading to its abandonment.

The elaborate and expensive modules in use on the Marseilles and Isabella I. canals are explained, but are interesting from their novelty rather than from any general use to our irrigation engineers. The spill-box of excess weir of Mr. A. D. FOOTE, of Idaho, is illustrated and described; and for this device readers are referred to ENGINEERING NEWS of Nov. 13, 1886, there illustrated. The principle of this device is one, or preferably two, spill-boxes, 16 ft. long and 14 ins. wide, set in the sides of the canal at a gate crossing the canal. The crest next the canal is brought to a sharp edge and is lower than the other three sides of the box. In the outer side of the box is a long slot closed by a sliding gate of galvanized iron, that can be adjusted at any desired opening and locked. Mr. W. H. GRAVES, of Monte Vista, and chief engineer of the largest canals in Colorado, was the first to introduce this spill-box on large canals, and has so modified it as to give most satisfactory results even under the most unfavorable conditions. Mr. GRAVES' design is fully illustrated.

The concluding portion of the bulletin is devoted to the discussion of weirs, including end contraction, conditions of rectangular weirs, FRANCIS' experiments on, and the CIPPOLETTE trapezoidal module. A series of tables of discharge over trapezoidal and rectangular weirs is given, ranging from a depth on crest of 0.3 in. to 36 ins.

—*A Description of the Memphis Sewer System, 1879 to 1890.* Compiled under the supervision of NILES MERIWETHER, City Engineer, by J. H. ELLIOT, Assistant Engineer. Pamph., pp. 31.

This report will be read with interest by all who have been watching the workings of the Waring system at Memphis. The greater part of the report is taken up with the annual reports for the years 1889 and 1890. The description of the system from 1879 to 1890 takes up but six pages of the report. First, Mr. WARING's description of the system is quoted from, and then extracts are made from the biennial reports of 1882, 1884, 1886 and 1888.

The extracts relate principally to obstructions, which increased rapidly in number and cost of removal from 1880 to 1886, but have since decreased, especially the cost of removing obstructions. The decrease is attributed to the introduction of manholes. The following summary presents the subject in a compact form:

| Years. | Obstructions. Number. | Cost of removal. | Average cost of removal. | Cost of cleaning main sewer. | Miles of sewers end of each period.* | No. of manholes built.* | Total number of manholes.* |
|---|---|---|---|---|---|---|---|
| 1881 and 1882..... | 75 | $1,013 | $13.50 | $285 | 37.7 | ... | 36 |
| 1883 and 1884..... | 164 | 1,982 | 12.10 | 739 | 41 | 12 | 48 |
| 1885 and 1886..... | 391 | 4,215 | 10.75 | 1,820 | 45.58 | 19 | 67 |
| 1887 and 1888..... | 229 | 2 511 | 10.96 | 1,612 | 47.77 | 19 | 86 |
| 1889 and 1890 ..... | 269 | 1,287 | 4.78 | 704 | 51.40 | 155 | 241 |
| Totals..... | 1,128 | 11,008 | ..... | 5,160 | 51.40 | 205 | 241 |

* Regarding both the total miles of sewers and the number of manholes, it should be stated that the figures for 1882 include 2.1 miles of old sewers purchased by the city and those for 1886 two miles more of the same, or a total of 4.1 miles of old sewers; also that in the years 1888, 1889 and 1890 about a mile of sewers was constructed independently of the Waring system. It is not stated whether number of hydrants, obstruction, cost of removing obstructions, and cleaning main sewers applies to only the Waring system or to the whole mileage.

From the above it will be seen that with the increase in number of manholes the number of obstructions diminished and the cost of removing them and of cleaning the main sewers grew rapidly less.

The report states that experience in Memphis has shown that the 6-in. pipe was too small as a unit, nearly all the stoppages occurring in pipe of this size; also that manholes are necessary for the economical working of the sewerage system.

The growth in population has been so rapid that relief sewers have been necessary in some parts of the city, the original pipe becoming overtaxed. Probably this overtaxing is in some measure due to the admission, without leave, of rainwater to the sewers.

—*Durability of Brick Pavements.* By IRA O. BAKER, Prof. of Civil Engineering, University of Illinois. Indianapolis, T. A. Randall & Co. Paper; 8vo, pp. 46. 25 cts.

This paper is the result of several years' investigation by the author with the purpose of fixing, if possible, some standard by which to judge of the quality of paving brick and its durability under traffic. These investigations include tests made at the university for transverse strength, absorption, specific gravity, crushing strength and loss by abrasion, with a discussion of this relative value of these tests. A subsequent chapter outlines the specifications required for paving brick, including quality; size and clay from which made. Under the head of durability, or life, of brick street pavements, much useful information is given, from the experience of the writer, the valuable paper of Capt. F. V. GREENE, presented to the Am. Soc. of Civil Engineers, and from the St. Louis experiments. Comparative experiments with brick and asphalt blocks, macadam, and limestone and granite blocks conclude the pamphlet. This work of Prof. BAKER is timely and valuable in enabling any one to obtain, for a very small sum and in handy shape, about all that is now known about this comparatively cheap form of street paving. It may be added that the general conclusions are exceedingly favorable to brick.

*Elements of Trigonometry*, with Logarithmic and other Tables. By Lieut. H. H. LUDLOW, U. S. A. New York, 1891, John Wiley & Sons. Cloth, 8vo, pp. 174 and 89. $3

This trigonometry was prepared for use in the West Point Military Academy, and has now reached its third edition, showing that it has proved adapted for school work. It contains nearly all the elementary matter in CHAUVENET'S "Treatise," the part devoted to spherical trigonometry being presented in a somewhat simpler form. The 5-place logarithmic tables, which are separately paged and apparently intended for separate publication, are particularly well arranged, resembling those of GAUSS in their general form.

—*Annual Report of the City Engineer of Waterbury, Conn.* R. A. CAIRNS, City Engineer, 1890. Pamph., pp. 30 and tables.

In this report attention is called to the fact that the city may at any time be obliged to adopt some method of sewage disposal other than the present discharge into the Naugatuck River, since complaints are arising against this method. A report from acting City Engineer F. W. WHITLOCK on sewage disposal at Worcester, is presented, and an illustrated article on the same subject is reprinted from our issue of Nov. 15, 1890.

—*Thirty-second Annual Report of the Maine Railroad Commissioners.* D. N. MORTLAND, A. W. WILDES, ROSCOE L. BOWERS, *Commissioners.* Augusta, 1891. Cloth bound, pp. 199, with map.

—*Water-Works Reports.*—The following reports have been received, the gentlemen named being superintendents unless otherwise stated: Gorham, N. H., T. E. PARK, Secretary; Burlington, Vt., F. H. CRANDALL; Dedham, Mass., W. F. HILL; Northampton, Mass., J. M. CLARK; Salem, Mass., H. W. ROGERS; Pawtucket, R. I., EDWIN DARLING; Bridgeport, Conn., G. RICHARDSON; Johnstown, N. Y., J. J. BUCHANAN; Potsdam, N. Y., W. F. P. SEALY; Rahway, N. J., H. B. BUNN; Mount Joy, Pa., W. KUHN; Bowling Green, O., J. H. WILKERSON; Battle Creek, Mich., W. W. BRIGDEN; Ishpeming, Mich., C. H. HALL; Manhattan, Kan., G. E. HOPPER; Hull, P. Q., J. O. LAFERRIERE, Secretary; Stratford, Ont., D. B. BARRITT, Secretary; Victoria, B. C., PETER SUMMERFIELD, Water Commissioner.

## SOCIETY PROCEEDINGS.

**New York Railroad Club.**—At the meeting on March 19, Mr. Alfred E. Hunt, President of the Pittsburg Reduction Co., will speak on "The Prospects of the Use of Aluminum in Railway Work" and Mr. C. T. Schoen, President of the Schoen Mfg. Co., will discuss the subject of "Pressed Steel in Railway Work."

**The Engineers of Roanoke, Va.**, civil, mechanical, and mining engineers and architects, held a meeting on March 7, at Roanoke, Va., with the object of organizing a state association in the interest of the branches named. Prof. ANDERSON, of Blackburg College, was the originator of the idea. Committees were appointed to confer with him, and also to secure suitable quarters for the association.

**The Engineers' Club**, of Duluth, Minn., was organized Feb. 21, 1891, with the following officers: President, Wm. B. Fuller, City Engineer, Duluth; Vice-President, L. F. Brewster, C. E., Duluth; Secretary, M. W. Lewis, Engineer of Design, City Works, Duluth; Treasurer, F. B. Edwards, Superintendent Sewer Construction, West Superior, Wis.; Librarian, S. A. Parsons, Assistant Engineer City Works, Duluth. The above, together with S. L. Rice, C. E., and Wm. H. Mahon, M. E., form the Executive Board. Meetings are held on the second Saturday of each month. M. W. LEWIS, Secretary.

**Liverpool Engineering Society.**—At the meeting on Feb. 18, Mr. James Morgan, vice-president, in the chair, a paper on "Foundations" was read by Mr. H. G. F. Barham. The paper first dealt with trial boring for foundations generally, and then passed on to a description of foundations on rock and firm ground, including the excavation of sumps, timbering and the preparation of rock surfaces. It then dealt with the various methods of forming foundations on soft grounds, and gave a description of foundations laid under water—first, by excluding the water by means of dams and coffer dams, and, secondly, without excluding water, by the use of various forms of concrete. It terminated with a consideration of pile foundations, pier sinking and pneumatic foundations.

# ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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Geo. H. Frost..... .....Business Manager

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**Advertising rates, 20 cents per line** *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

**Drawings and Photographs** *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*


### COMING TECHNICAL MEETINGS.

***Western Railway Club.***—March 17, "Car Lighting and Interchange Rules," Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

***Engineers' Society of Western Pennsylvania.***—March 17. Secy., S. M. Wickersham, Pittsburg, Pa.

***Boston Society of Civil Engineers.***—March 18. Secy., S. E. Tinkham.

***American Society of Civil Engineers.***—March 18. Secy. Francis Collingwood, 127 E. 23d St., New York.

***Engineers' Club of St. Louis.***—March 18. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

***Engineers' Club of Cincinnati***—March 19. Secy., J. F. Wilson.

***New York Railroad Club.***—March 19. Rooms, Grisey House. Secy., H. G. Prout.

***Southern and Southwestern Railway Club.***—Memphis, March 19. "Side Rods, Exhaust Pipes."

***Engineers' Club of Philadelphia.***—March 21. Secy., Howard Murphy, 1129 Girard St.

***Denver Society of Civil Engineers.***—March 24, "Underground Surveying." Secy., Geo. H. Angell.

***Western Society of Engineers.***—April 1. Secy., J. W. Weston, 230 La Salle St., Chicago.

***Engineers' Club of Minneapolis.***—April 2. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

***Technical Society of the Pacific Coast.***—April 3. Secy., O. von Geldern, 408 California St., San Francisco.

***Northwest Railroad Club.***—April 4. Secy., H. P. Robinson, St. Paul, Minn.

***Civil Engineers' Society of St. Paul.***—April 6. Secy., C. L. Annan.

***Civil Engineers' Association of Kansas.***—April 8. Secy., J. C. Herring, Wichita, Kan.

***New England Railroad Club.***—April 8. Secy., F. M. Curtis.

***Engineers' and Architects' Club of Louisville.***—April 8. Secy., G. W. Shaw.

***Northwestern Track and Bridge Association.***—April 10. Secy., D. W. Meeker, St. Paul, Minn.

***Engineers Club of Duluth.***—April 11. Secy., M. W. Lewis.

***Engineers' Club of Kansas City.***—April 13. Rooms, Baird Building.

***Civil Engineers' Club of Cleveland.***—April 14. Secy., A. H. Porter, 50 Euclid Ave.

***Engineering Association of the South.***—April 14. Secy., John H. Landreth, Vanderbilt University, Nashville, Tenn.

A GENERAL INDEX TO ENGINEERING NEWS, extending from the first issue of Volume I., in 1874, to the end of Volume XXIV. (July–December, 1890), is now in press, and will be issued about April 15, in a separate small volume handsomely bound in cloth, which will be sold at $1. It will prove a valuable work of reference even for those whose files are not complete.

THE fact that the United States has doubled its production of iron since 1882, and is now the largest producer in the world, strange to say, excites little comment on the part of our English contemporaries. The London *Railway News* lets its home readers down easily by prefacing its statement on this head with the remark that, "As might have been predicted from the vast extent of its mineral deposits, the United States has attained," etc. The same journal also finds some comfort in the concluding statement that "the whole of the American production is consumed at home, and is, moreover, supplemented by the importation of a good deal of manufactured iron and steel in various forms." Fortunately, perhaps, for our contemporary, it has made no attempt to fix dimensions to this "good deal," nor to contrast it with the importations from England of a few years ago. Individually, we have no wish to see the United States prosper at the expense of a nation so near akin to us as England; but when American production exceeds home consumption, as it must in the natural course of present events, we may hear more vigorous comments and suggestions from our neighbor across the sea.

WE have been shown this week a mechanical monstrosity, the enormity whereof we trust was not realized by its maker, viz.: a *cast iron coupler knuckle*, made in imitation of the wrought iron knuckle of the Janney coupler, with the apparent hope that it might be mistaken for the cast steel knuckle used in some other makes of M. C. B. couplers, and so pass inspection at the junction points. That this casting, moreover, was made with the intent of making still others, and not merely because of some sudden emergency, is indicated by its bearing a pattern mark, "*E* 10." As was to be expected, the knuckle broke almost as soon as it left the shop, as evidenced by the fact of the sand being hardly worn off from the inner face of the casting. Still, it was enough worn off to indicate that the knuckle might have run 100 to 300 miles before it broke. That it broke in the hands of innocent third parties is indicated by the fact that the bogus knuckle was turned in in good faith for renewal, along with other genuine ones.

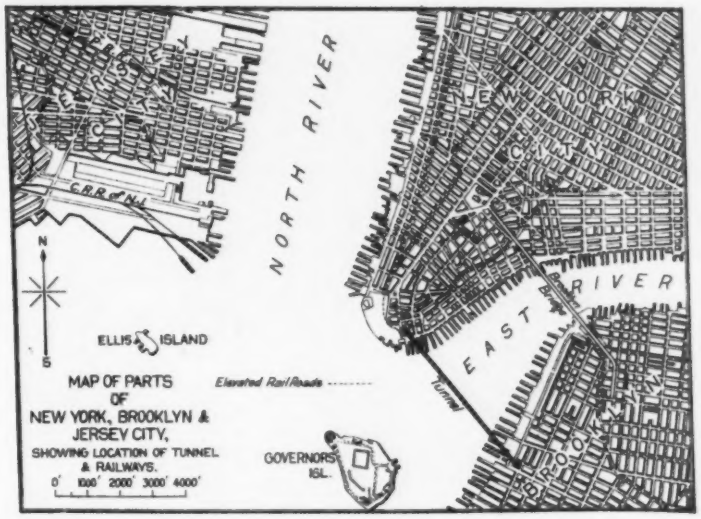
The road which was guilty of such trifling with human life as is involved in such a deception is not known, which is perhaps fortunate, as we should have felt bound to make its name as prominent as possible, and it may be that this act was one of mere thoughtlessness rather than of deliberate intent. But it is almost needless to point out the enormity of such a deception from every point of view. The strains to which the knuckles are subjected are very severe, and it was almost a certainty that one made of cast iron would soon break, and very possibly on the open road and on an up grade, with the inevitable consequence of a breakaway. It is believed from some circumstantial evidence that the knuckle was fabricated on some Western road, and the inference is natural that it was fabricated by some one more or less hostile to the M. C. B. type, since there are already so many M. C. B. couplers in service (considerably over 10 per cent. of the total freight car equipment, according to our returns) that every considerable road has occasion to have knuckles in stock for repairs, and genuine ones could have been obtained from the manufacturers or other roads with but a few hours' delay.

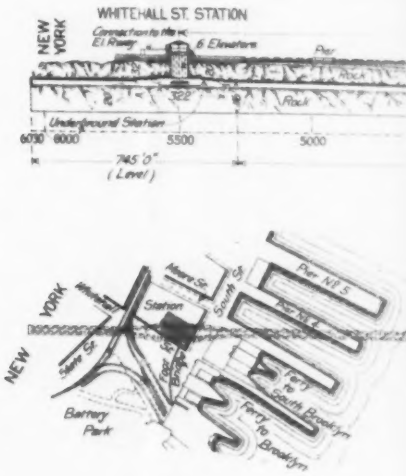
THE fact that such bogus knuckles are in circulation, even if few in number, seems to indicate that special caution should be enjoined upon inspectors at junction points, that accidents may be avoided and the guilty parties detected. We have little doubt that they could be prosecuted under the common law, but the more important immediate issue is to prevent such substitution of inferior material in the future by some change in the Interchange Rules. All that these rules say is: (Rule 15) "The work [on foreign cars repaired] shall conform in detail to the original construction, and ['shall be made" should be inserted] with the same quality of material originally used." This is not sufficient, even if lived up to in intention. The several parts of air brakes and M. C. B. couplers are special products, requiring great skill and experience and special appliances to manufacture of good quality. Under existing conditions the makers have the strongest interest in making them of the best possible quality, and supplying them at reasonable rates. There would, therefore, be no hardship and great gain, under present conditions, in a new rule requiring that all parts for repairs of automatic brakes and M. C. B. couplers, which had been applied to some minimum number of cars, should be obtained from the manufacturers, with some reservation of authority to the Executive Committee of the M. C. B. Association to waive this requirement in the case of manufacturers whose prices for renewal parts were found unreasonable. If, in addition, it were required that cars fitted with air brakes or couplers not yet in such general use as to be applied to the minimum number of cars should carry a spare knuckle, etc., in some suitable receptacle, the dangerous results which are certain to flow from unchecked substitution of any kind of material for broken parts would be effectually averted.

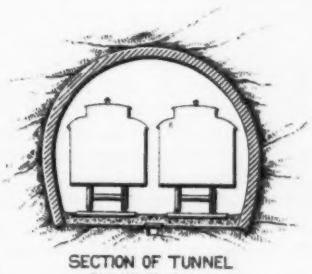
WE may further note, in this connection, a significant fact: The standing offer of the McConway & Torley Co. to guarantee their couplers for 5 years or longer,* at the rate of $1 per car per year, which has been extensively advertised in this and other journals since Jan. 24, 1891, has not yet been accepted by a single company, while a number have distinctly declined to enter into such an agreement on the ground that they would lose money by doing so. Not only has this offer been extensively advertised, but it has been called to the attention of all or most of the 40 or more lines using Janney freight couplers by personal letters, but not a single company is known to be even seriously considering the offer. This being so, it is certainly a striking confirmation of the essential correctness of our estimates of Feb. 15, 1890, where we found the total cost now "in sight," from the indications of current returns, to be only 75 cts. per car per year, of which only 29 cts. was for the present a charge on the companies, the rest being borne by the manufacturers. We have as yet seen no reason to believe that this is much, if at all, below the probable average cost of maintenance in future years, for what is lost from greater average age of couplers should be more than made up from improvements in handling the cars, and above all, in finally dispensing with the slot and pin hole for link coupling, where the great majority of the fractures occur. The latest evidence, moreover, tends to show that the wear of the inside face of freight car knuckles is so small as to be almost negligible. In passenger service it is very great, because the knuckles are pressed together with a force of some 8,000 lbs. by the buffer springs, while the long cars and their easy swing movements cause a good deal of motion; but in freight service this is not so, and we learn that on a gravel train on the Chicago, Burlington & Quincy, which has been in constant daily service for 3½ years, the wear of the inner face is still hardly noticeable (possibly $\frac{1}{16}$ in.) though the knuckles are covered with gravel a good deal of the time.

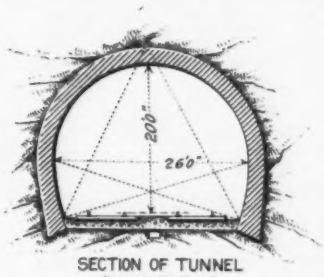
THE Russian Committee of Ministers, to whom the question was referred, has decided to build the Siberian Pacific Railway within the next 6 years. This is evidently a compromise between the 3½ years

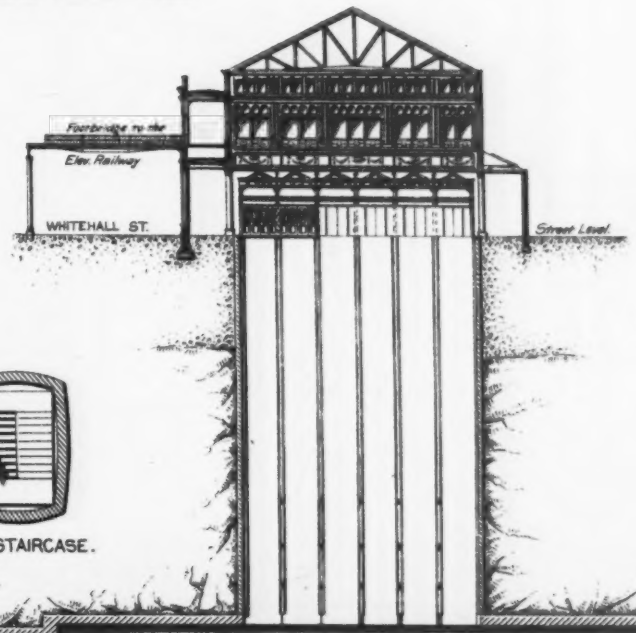
*This offer as first made (Jan. 24) was for 5 years simply. On Feb. 14 it was extended to cover 5 years *or longer*.

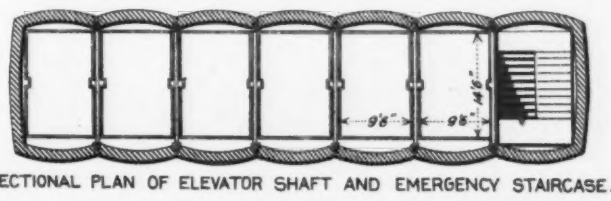


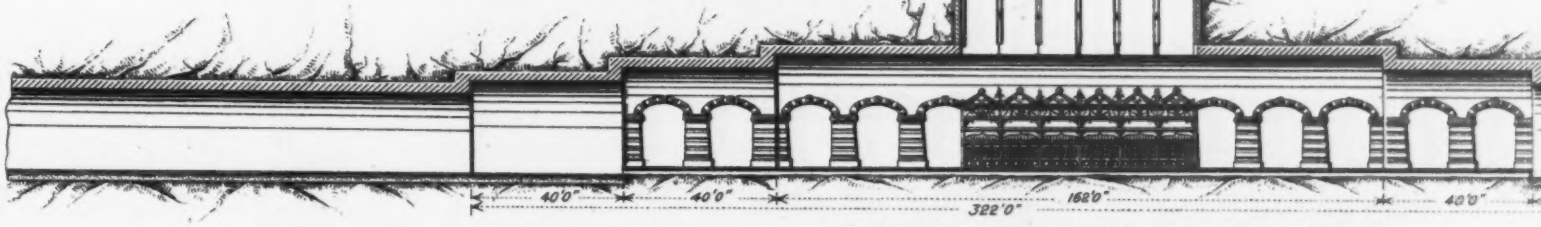



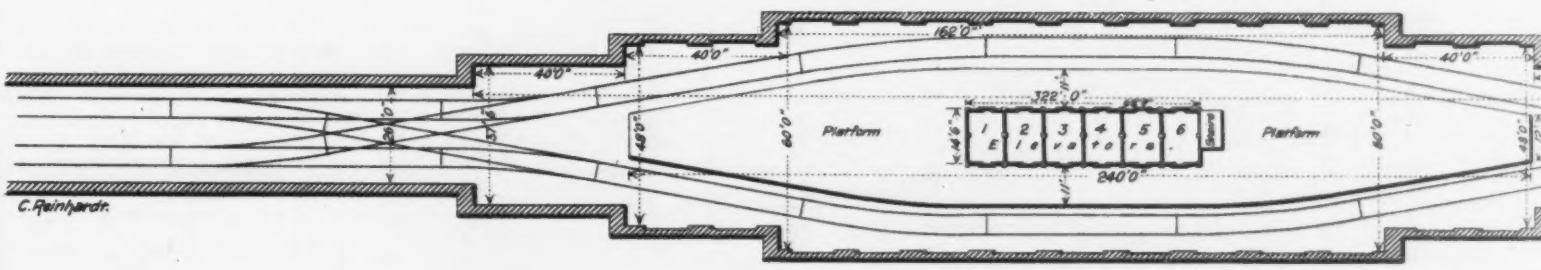






SECTIONAL PLAN OF ELEVATOR SHAFT AND EMERGENCY STAIRCASE.




LONGITUDINAL SECTION THROUGH UNDERGROUND STATION.

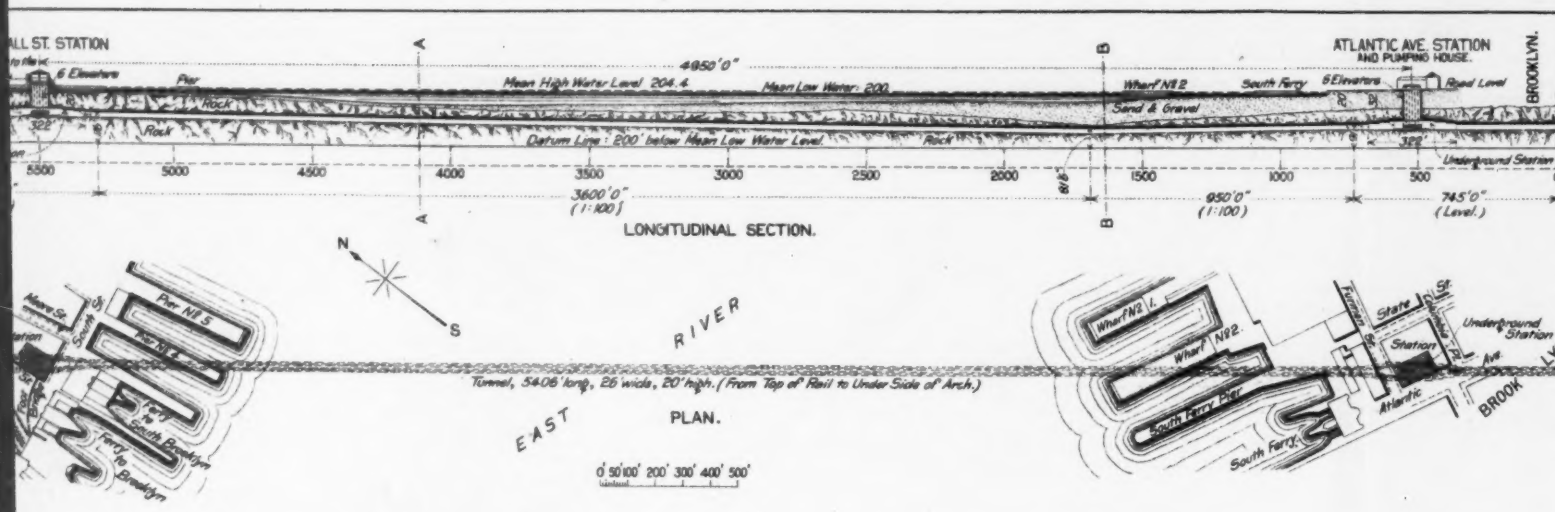


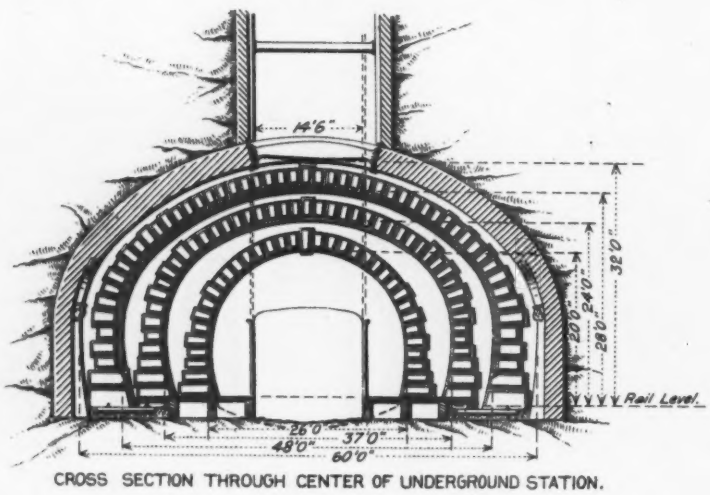

PLAN OF UNDERGROUND STATION.

# PROPOSED EAST RIVER TUNNEL OF THE M

## BETWEEN NEW YO

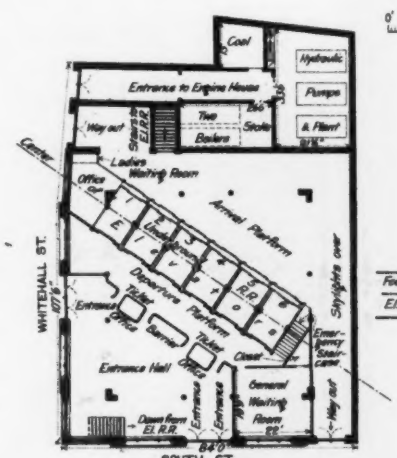
CHARLES M. JACOBS.



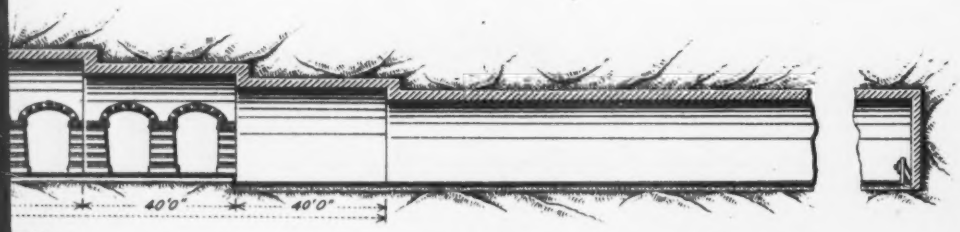

CROSS SECTION THROUGH CENTER OF UNDERGROUND STATION.

0' 10' 20' 30' 40' 50'



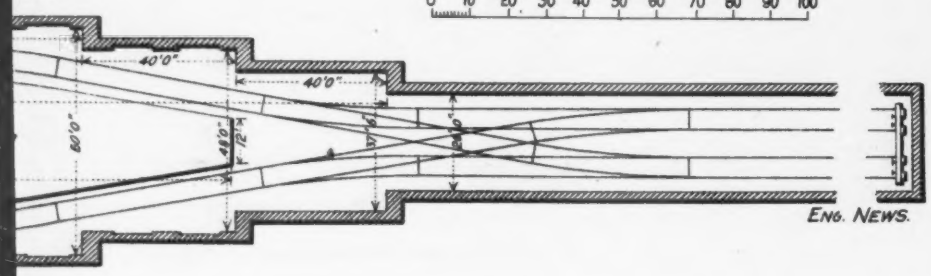

GROUND PLAN.

FIRST FLO

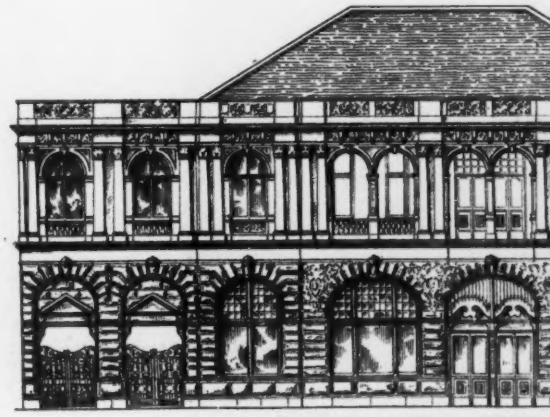



TION.

0' 10' 20' 30' 40' 50' 60' 70' 80' 90' 100'




ENG. NEWS.

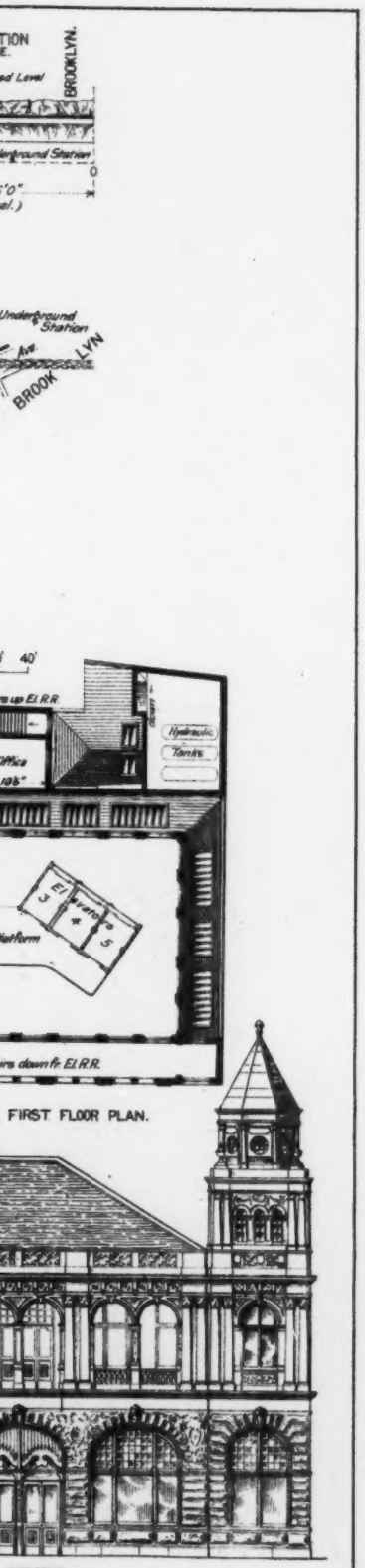


ELEVATION ON WHITEHALL STREET.

# EL OF THE METROPOLITAN UNDERGROUND RAILWAY CO.

## TWEEN NEW YORK AND BROOKLYN.

CHARLES M. JACOBS, M. I. C. E., ENGINEER.




CHAS. HART & SONS, LITH., 88 VESEY ST., N.Y.

in which Gen. ANNENKOFF, the builder of the Trans-Caspian Railway, says he could construct it, and the 12 to 13 years spoken of originally by the ministers. The Minister of War has concurred in the above resolution, and Russian engineers rejoice at the prospect of abundant work. The fulfillment of this promise means that a journey of about one month overland will take the traveller from St Petersburg to the Sea of Japan; in fact, to Japan itself. According to the latest accounts, however, the first lines of railway built will only unite existing waterways, leaving the connecting links of rail to be put in later. The west starting point of the system would be at Tomsk, which is now connected by rail with European Russia. The line to Irkutsk, close to Lake Baikal, would be 940 miles long. Another line of about 60 miles would connect the southeast end of the Lake with Sazetensk, on the Amoor River; and 230 miles of rail would connect Srafsikaja, on the lower river, with Vladivostock, on the Sea of Japan. The total length of rail and water route would be about 5,000 miles.

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ANOTHER and equally significant piece of Russian railway building, practically determined upon at St. Petersburg by the same committee, is the line to connect Vladikavkas at what is now the extreme southeast terminus of the St. Petersburg—Moscow system of railways, with Baku, the eastern end of the now isolated Trans-Caucasian Railway. The nominal purpose of this line is to still further develop traffic on the Trans-Caspian Ry. to Samarkand, and this is doubtless a useful purpose. But the link proposed would also take the Russians directly by rail from St. Petersburg to the northwest boundary of Persia and to Turkish Armenia, regions toward which the Russian Czar has been making some vigorous pushes in the past and is now accused of seeking "to protect." The connecting link would require something less than 400 miles of railway to reach Baku, and the country is not a difficult one to build through. Vladikavkas is now connected with Rostov, at the head of the Sea of Azov, by about 400 miles of an excellently built railway. And while the Caucasus Mountains abut squarely against the Black Sea, with precipitous shores that practically forbid railway building, the range lowers as it approaches the Caspian in such manner as to leave a flat shore along this sea, and the axis of the range is very near Baku. At the latter point it is only about 200 miles across the Caspian to the western end of the Trans-Caspian system. It may be also interesting to note that the Caucasus Mountains maintain an almost unbroken high crest from the Black Sea to near the Caspian Sea. The Dariel Pass is the one road over this range between these two seas; and while Vladikavkas and Tiflis, about midway on the Trans-Caucasian Railway, are only 130 miles apart, the summit between is 8,000 ft. above the sea. Rumors have been current for some years past of a proposed tunnel line to connect these two points; but personal inquiry on the ground, last summer, failed to gather any satisfactory news concerning its progress from Russian engineers. It was reported, however, in Tiflis that Russian soldiers were at work tunnel-driving southwest of Vladikavkas.

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## American Practice in Cheap Railway Construction.

Few of our readers can have wholly forgotten a paper under the taking title of "The Cheapest Railroad in the World," read by Mr. ARTHUR PEW before the American Society of Civil Engineers at its last annual convention, and published in abstract shortly thereafter in this journal.* The line in question was the Dublin & Wrightsville Railroad, a short line to connect two villages with those names 19 miles apart, and of this line Mr. PEW was Chief Engineer. The story of its construction he has told in his paper; the story of its successful operation is told in figures now before us. Taking both together, no line could better illustrate in little the daring enterprise by which this continent (or our part of it, at least) has been covered with a network of lines constructed by private enterprise at a minimum of original investment, and yet so well adapted to their work that they furnish also the cheapest transportation in the world, and ultimately develop into well-constructed railways.

First, as to the construction, we rehearse a few facts from Mr. PEW'S original paper. In the fall of 1884 the company was organized and $22,600 of stock subscribed ($1,160 per mile), of which it was expected to collect three-quarters in instalments of 10 per cent. per month, with enough new subscriptions to make up the deficiency. With this small sum it was hoped (and not without reason, for it was done) to make the roadbed ready for the rails, and to obtain the rails and rolling stock from the Central Railroad of Georgia.

The route was timbered and moderately rough, passing a navigable river and a considerable "creek" (which was also a pretty good-sized river), both of these streams lying about 100 ft. below the general level of the country. The grading averaged about 4,000 cu. yds. per mile, and 40 convicts, hired at $1 per day, did this work at 9 cts. per cu. yd., and hewed ties at 9 to 10 cts. each from the timber on the right of way, which latter was for the most part given. On Dec. 1, 1885, 11¼ miles had actually been completed, and were in operation, at a total cost of $1,005 per mile for clearing, grubbing, grading, trestles, crossties and ditching, or $1,164.49 per mile including also engineering and right of way, for which latter $700 in all had then been spent.

To complete the superstructure an arrangement was made with the Central Railroad of Georgia (to which the new line would be a feeder), under which that company agreed to furnish good second-hand rails (40 to 45 lbs.), and sufficient second-hand frogs, switches, joints and spikes, and to lay and surface the track, all for the sum of $35,000 in preferred 6 per cent. stock, accompanied by a further obligation that the line should be finished without incurring a bonded debt. This was considered to be somewhat under the market value of the material and service, amounting to less than $28 per ton of rails furnished, or some $1,842 per mile of main track. Possibly a friendly respect for the pluck of the projectors had something to do with the terms offered by the Central of Georgia.

When the whole 19 miles were finished, the total cost, apart from track, was $1,599 per mile, to which add $1,842 for track, as above, and we have $3,441 per mile ($65,380 in all) as the total cost of the road ready for rolling stock. It was estimated that $1,000 per mile more would have given it all the rolling stock needed for its thin traffic, but this was made unnecessary by the fact that this new road was merely an extension of a little 16-mile existing road, the Wrightsville & Tennille, with which it has since been consolidated. This latter road had been built in somewhat the same way, but with less care and good fortune, and so had cost more money. The total of stock and bonds of the consolidated company was as follows:

| | Total. | Per Mile. |
|---|---|---|
| Capital stock | $119,622 | $3,306 |
| Bonded debt | 35,000 | 903 |
| Total stock and debt | $154,622 | $4,386 |

This road, be it remembered, is of standard gage (4 ft. 8½ in.), a fact which we commend to the thoughtful attention of narrow-gage cranks the world over, if there are any such left. The road was carefully located, with 6° maximum curves and few of these, no reversed curves, 140-ft. minimum tangent, and 1½ per cent. maximum grades. For such a line and traffic the adoption of a grade high enough to almost follow the surface was good engineering practice.

It will be seen from this summary: (1) That the road was built for cash and not for bonds, (2) that there were no profits to middlemen, (3) that an exceptionally good bargain was made for the track, (4) that extreme economy was used in all the details of construction, to which it is but fair to add (5) that the engineering work was well and carefully done. In some of these respects it differs markedly from average American practice; but in the broader features, of cutting one's coat according to one's cloth and managing to do much with little when only a little can be had, it is a type of the methods by which a large majority of American railways have been carried through to completion.

What has been the result? Simply this: that the road was not only the cheapest in the world in first cost, but is also one of the most profitable, and that out of these profits a sum considerably exceeding the total original investment has been expended in improving the property within the 4½ years since the road was opened. The brief report of the President, in which these striking facts are chronicled, now lies before us, and we deem it of sufficient interest to give it almost in full, italicizing certain specially notable statements:

TENNILLE, Ga., Jan. 1, 1891.

TO THE STOCKHOLDERS: We have just finished the most successful period in the business of the Wrightsville & Tennille R. R. Co. The earnings since June 30, 1890, to the 1st inst. have been $49,866.27, and the expenditure for same time $36,366.58; net earnings, $13,499.69; included in the expenditures is amount paid for new rails, $8,200, leaving as the true net earnings *in the six months, after paying the fixed charges for that term*, $21,699.69, which is a little over 17 per cent. on capital stock

There were also extraordinary amounts paid in settlement of suits for damage and for additional taxes, which are in no way connected with the business of the period, as follows [details omitted], making $4,374, which should be considered to the credit of net earnings in comparison with former seasons, and which would have made us 20 per cent. net in the six months after paying fixed charges (interest on bonded debt).

The work for the extension of the road into Dublin is all under contract, and is progressing satisfactorily. This extension will cost you about $25,000, and will be completed this spring. The finances of the company are in such shape as to meet the payments on this work of extension, and warrant the payment of the 8% dividend declared by the Board of Directors at their last meeting, and payable to-day.

On account of the financial success of your company in the past years, *your Board recommends to you that the capital stock of the company be doubled and a share of stock of equal value and tenor be issued to all stockholders for each share of stock they hold*, as appears on the company's books Feb. 1 next, provided the Central R. R. will accept a double amount of stock at half the rate of preferred dividends. This increase, they think, is warranted from the following facts:

The net earnings of the company, as shown by the annual reports, have been as follows:

| | Net earnings. |
|---|---|
| 2d year, 1884-5 (11 miles operated) | $3,005 |
| 3d " 1885-6 (16½ " " ) | 12,356 |
| 4th " 1886-7 (35¼ miles open Nov., '86) | 31,956 |
| 5th " 1887-8 " " " " | 34,646 |
| 6th " 1888-9 " " " " | 33,137 |
| 7th " 1889-0 " " " " | 36,390 |
| 6 mos. of 8th year, 1890 (35¼ miles open Nov., '86) | 21,699 |
| Total (144% of first cost) | $173,270 |
| Of this amount, there has been paid out in dividends | $23,438 |
| In interest on bonds, etc | 7,160 |
| Leaving a net balance (119%) of | $142,672 |

or $22,000 more than the total amount of the capital stock of the company issued, and *of this amount, all has been applied to betterments and improvement to the company's property, or is surplus now in the treasury.* We are satisfied that by judicious management and development of territory, the earnings of the company will pay dividends sufficient to make the stock worth par within a year or two. It is further recommended that this meeting concur with the Board in placing a small bond on the road for purposes of extension and improvement.

It is with justifiable pride that we refer to the improved physical condition of the road, which has steadily increased since the opening, and the excellent train service, which is evidenced by *not having had only one casualty sufficient to cause us to miss a connection in two years*, and that from the trivial cause of bursting

*For the paper in full see Trans. Am. Soc. C. E., Sept. 1890. For an abstract see ENGINEERING NEWS, Aug. 9, 1890.

a steam pipe connecting the injector to the boiler of engine. Respectfully submitted,

W. B. THOMAS, Pres't.

This is assuredly a record to be proud of, and we need hardly say that the "watering" of stock now proposed is an entirely justifiable measure, representing as it does money actually expended in settlements. The same is true of many another American line which has watered its stock heavily, and got much abuse for it, and it is more or less true of nearly all such lines. We must not be understood to deny that there are many abuses connected with such stock watering which ought to be checked by law; but that there is any such proportion of purely fictitious stock as is often assumed we do not believe, nor do we see why the natural increase in the value of a railway property, should not be represented by an additional capitalized value, just as is the growth in value of a piece of real estate, whether or not the increment of value arises from a corresponding investment of money in the property. An argument of great strength can be made against permitting individuals to pocket such "unearned increments" in either case, but it is not clear to us why the argument is any stronger in the one case than in the other, nor how it can well become so until the construction of a railway is put upon some other basis than that of a purely private venture.

It is a significant fact that it is in this country alone that private enterprise has proved equal to furnishing the necessary lines for thin traffic, so that the whole country may be well provided with railway facilities, as fast as (or faster than) it affords adequate means for supporting them. The contrast in this respect between the United States and the British colonies is, we cannot but think, highly significant. Both in Canada and in the Australian and Cape colonies, not to speak of India, which is a problem by itself, the railway system is almost wholly the creation of the government or of governmental aid. Without such aid it may fairly be inferred that not half or a quarter of their present mileage would exist; and yet there are few if any lines in any of these colonies which had not as good a prospect before it as had the little Georgian line which furnishes a text for this article, while most of them had far brighter prospects.

On the other hand, the railways of Great Britain are practically all of them the creations of unaided private enterprise; but that system hardly affords a proper comparison, because there already existed both a large and certain traffic and ample capital for construction. We are not belittling the enterprise which led to the early construction of the British railway system. On the contrary, the resemblances between the records of British and American railway enterprise, in contrast with the rest of the world, are much more striking than the contrasts with each other. Nevertheless, the internal contrasts, so to speak, are of some significance, especially between the more thinly settled regions of the United States and the British colonies. Governmental aid or governmental construction has been the all but universal practice in those colonies. Railways built chiefly on faith and hope by individual enterprise alone to create and not to secure a traffic have been the rule in this country, and they are a phenomenon peculiar to the United States.

Even such a property as the New York Central, for example, is nothing more than a consolidation of a dozen or twenty of such enterprises, which in the beginning were regarded as almost as hazardous, and were certainly almost as poor as the modern line whose story we have chronicled. Why should individual enterprise have proved unequal to supplying a railway system to colonial communities, which have certainly shown no little enterprise in their collective capacity? It is a question we cannot answer. We simply note the fact as a curious phenomenon.

## CORRESPONDENCE.

### The Cheapest Railroad in the World.

TALBOTTON, Ga., March 3, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have recently collected some more information in regard to the "Cheapest Railroad in the World." I have had this printed to send out with some extra copies to friends not members of the society.

I send you by this mail a copy of the paper and also inclose a copy of the additional information referred to.

I also inclose a copy of the last report of ex-President W. B. THOMAS. This was issued to the stockholders about the last of January, but I have never seen any notice of it in the papers. ARTHUR PEW.

[We have to thank our correspondent for the very interesting information inclosed in his letter, which we deem of so much interest that we summarize it editorially as an excellent example of "American Practice in Cheap Railway Construction."—ED. ENG. NEWS.]

### The Pegram Truss.

TO THE EDITOR OF ENGINEERING NEWS:

The three bridges for the Missouri Pacific Ry., designed by Mr. GEO. H. PEGRAM, and illustrated in your issue of Feb. 14, strike me as very good structures, as truss bridges go, and he makes some good points in favor of it in his letter in the following issue. But are there not other types of bridge which are equally strong and stiff to resist the strains from derailment, contraction and expansion, and the shocks from driftwood at high water, and which have also no weakness about the end panels? I believe that there are, and that the short (100 ft.) span illustrated was an expensive bridge to build, compared with what might have been put up.

Mr. PEGRAM also claims that his type of truss is more economical than other truss bridges; but I do not see why this is so, and hope he will give us the reasons.

X. Y. Z.

It takes no great penetration to discover that our correspondent is a strong partisan of rolled beams, plate girders and riveted trusses for all bridges, except, perhaps, those of very long span. Undoubtedly many points of superiority claimed for the Pegram truss are perfectly secured by a rigid riveted construction; but on many roads remote from the iron-producing districts the truss bridge is still much cheaper than the girder. The cost of freight and erection, as well as the first cost at the shops, have to be considered, and what is the cheaper for a road in Pennsylvania may be the dearer for a road west of the Missouri.

The peculiar advantages of the Pegram truss in point of economy were fully explained and illustrated in our issues of Dec. 10 and 17, 1887. The saving is due chiefly to the use of short compression members and long eye bars, while the web members decrease in length toward the ends, where the strain is greatest. Thus a reduction in the weight of the truss can be made. The shop work is also less than with a common truss. The possible saving is estimated at from 6% upward.—ED. ENG. NEWS.]

### The Calculation of Overhaul.

GRANT, Va., Feb. 9, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Jan. 31 a method of estimating overhaul by a profile of quantities, by S. B. FISHER, is published. I have used a method somewhat similar to that, which is illustrated in the accompanying diagram. This method consists in plotting the quantities in the cuts, and fills an ordinary pronle paper, and preferably on the same paper on which the ordinary line profile is plotted, using the same horizontal scale, and placing the stations for the quantity profile directly above or below those on the ordinary profile, as in the diagram here given.

These quantities are final quantities calculated from the construction cross-section notes. Each cut and fill is plotted separately—cuttings in red (heavy solid lines in diagram), and fills in blue (heavy dotted lines); the origins or zero points being at the stations or plusses where the changes from cut to fill occur. From each of these grade points as an origin the total quantity in each cut and fill up to each station is plotted opposite each station, so that in the curve of quantities thus produced an ordinate at any point represents the total quantity in the cut or fill from its beginning up to that point. By plotting backwards in the same manner we obtain two curves, which are symmetrical about a horizontal line through their point of intersection, and which intersect in the center of gravity* of each cut and fill.

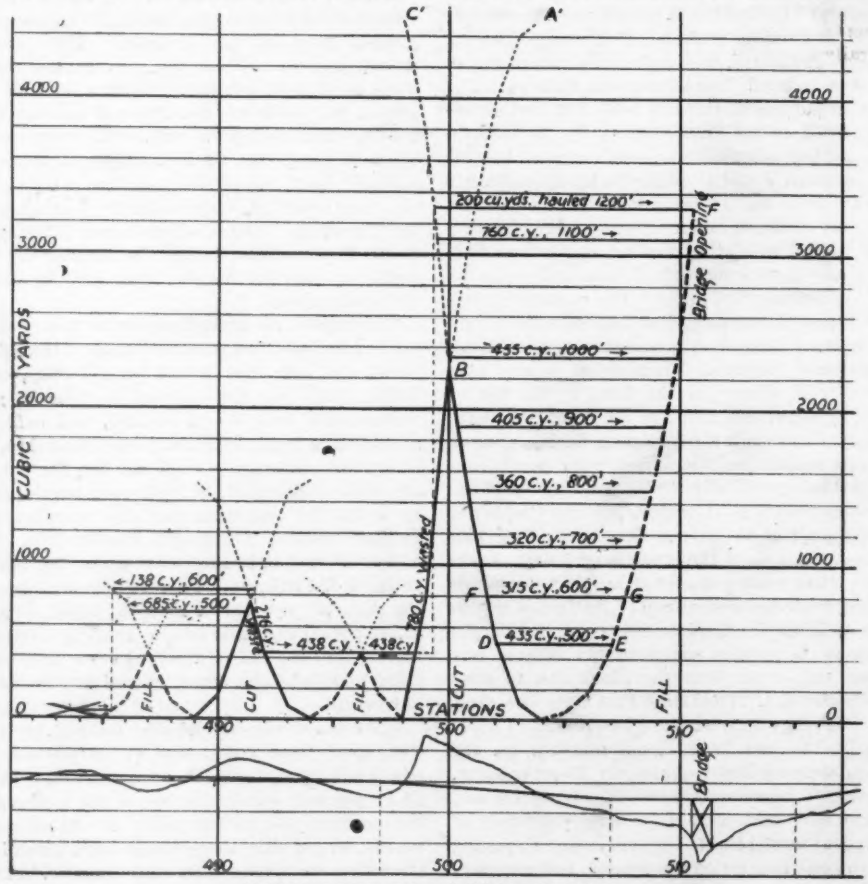



DIAGRAM FOR CALCULATING OVERHAUL.

The method of using this profile of quantities can be best understood by referring to the accompanying diagram. The cut from Sta. 490 + 30 to Sta. 504 will be hauled into the fill from Sta. 504 to the bridge opening at Sta. 510 + 75. *A, B, C'* and *A', B, C* are the quantity curves

* Our correspondent here errs. It is not the center of gravity, but the center of mass. The moments of the equal masses on each side may be very different.

for this cutting, plotted from the grade points in opposite directions. They intersect at *B*, at Sta. 500, which is therefore the center of gravity of the cutting. *A, E, G, F* is the quantity curve for the fill. It is plotted one way only, because this fill can be made only by hauling one way, on account of the bridge opening. Supposing that earth is paid for at 16 cts. per cu. yd. up to 500 ft. of haul with an addition of 1 ct. per yd. for each additional 100 ft. of haul: First find, with a scale or pair of compasses, the two points, one on the curve *A, B, C*, and the other on *A, E, G, F*, which are exactly 500 ft. apart on a horizontal line, and draw a line between them, the line *D E*. These points represent, on the horizontal scale, the stations between which the haul reaches 500 ft., and the ordinate at *D* or *E* represents the number of cubic yards hauled up to the 500 ft. limit. Now, find two points on these curves which are 600 ft. apart on a horizontal line, the points *F* and *G*. These mark the limits of the 600-ft. haul, and the vertical distance between the lines *D E* and *F G* gives the quantity of earth hauled 600 ft. In the same way the quantities hauled 700, 800, 900 ft., etc., can be determined, and the stations which mark the limits of these different lengths of haul are found.

Having thus disposed of that part of the cutting from Sta. 499 + 30 to Sta. 504, we turn to the curve plotted from the grade point at Sta. 498, and find that by hauling backward from 498 + 50 to 496 + 20 we can make just half the fill at Sta. 496; the total quantity hauled being 438 cu. yds., and the maximum distance 230 ft. The balance of the cutting from Sta. 498 + 50 to Sta. 499 + 30, amounting to 780 cu. yds., must be wasted.

It will be readily seen from a study of this method that an engineer can tell in advance where to direct the contractors to borrow and where to waste, and can determine the most advantageous method of hauling out his cuts as soon as he gets his work cross sectioned and his quantities calculated.

Of course if rock is struck in unexpected places, and the quantities are thereby changed, it will be necessary for him to change his curves, and for this reason it is better not to ink in his quantity profile until the work is finished.

I am indebted to R. R. BRUER, C. E., of the C. P. R., for this method of calculating overhaul.

T. S. RUSSELL.

[This method is new to us, and seems to have some very good points in its favor.—ED. ENG. NEWS.]

MINNEAPOLIS, Minn., Feb. 20, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: While the subject of overhaul is receiving a share of your space, permit me to offer the following:

Believing with Mr. FISHER that no uniform method for calculating overhaul is practiced among the engineers of this country, the writer, after a careful reading of Mr. FISHER'S plan, without questioning the accuracy of the scheme, fails to find the "facility" claimed for it.

Overhaul, if a stumbling-block at all, becomes so by its extreme simplicity, and needs no elaborate scheme to bring the results within the degree of accuracy demanded by good practice.

According to the usual wording of the contract relating to overhaul, the engineer proceeds as follows to determine the extra price per yard due the contractor by reason of having moved a certain quantity of material further than the "limit of overhaul."

1. Locate, on the profile, the two stations or pluses whose distance apart is the limit of overhaul, between which two points the cut will just make the fill; shrinkage considered if necessary.

2. Locate the center of gravity of that part of the remainder of the cut which it is designed to put into bank.

3. Locate the center of gravity of that part of the bank beyond the limit of overhaul which is made from the cut.

4. From the distance between these two points take the limit of overhaul, and the remainder, calling 100 ft. the unit, is the number of cents per yard extra due the contractor, the basis of extra pay being one cent per cu. yd. per 100 ft., which is customary.

Details might be given as to the exact manner of finding the points under (1) and the plus of the center of gravity, but are thought unnecessary, for it would seem quite like explaining to an engineer or architect the manner of finding the logarithm of a number—that with which he is or should be perfectly familiar.

W. R. H.,
University of Minnesota.

WINOOSKI, Vt., Feb. 18, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I inclose you an example illustrating the method of computing overhaul which I have used for several years, and which seems to me to be less complicated than most ways of figuring, and about as nearly accurate.

The process consists simply in figuring the overhaul on the excavation and embankment separately, figuring each as if it was drawn to the limit of free haul and there dumped.

The example does not need much explanation. The first two columns are copied from the cross-section notes, and should include all the pluses. The next three columns explain themselves. In case of swell of material, another column could be ruled for that purpose. In the example taken, I have assumed the limit of free haul as being 500 ft. and the limit of extreme haul as 1,500 ft., which gives free haul from station 229 + 90 to 234 + 90, and the limit of extreme haul from station 218 + 60 to 233 + 60.

In the excavation the free haul ends and the overhaul commences at station, 229 + 90; therefore the quantity between there and station 230 has an average haul from station 229 + 90 to 229 + 95, or 5 ft., and from 230 to 231 has an average haul from 229 + 90 to 230 + 50, or 60 ft.

EXAMPLE OF COMPUTING OVERHAUL.

*Excavation.*

| Station to Station. | Cubic yards in cross-section. Notes. | Cu. yds. hauled, not included in cross-sections, as ditches, borrow, etc. | Cu. yds. waste, as rock piled and not hauled. | Total cu. yds. hauled. | | Av. haul from Sta. to Sta. | Average haul in Sta. | Overhaul, or cu. yds. hauled 100. |
|---|---|---|---|---|---|---|---|---|
| +80 | 10 | 5 | ..... | 15 | 229 + 90 limit free haul, 417 cu. yd. | | | |
| 228 | 70 | 27 | 5 | 92 | | Haul betw. 229 + 90 and 229+95 | .05 | 2 |
| 229 | 120 | 10 | ..... | 130 | | | | |
| +40 | 200 | 16 | ..... | 216 | 229+90 | | | |
| 230 | 400 | 25 | 25 | 400 | 233 + 60 limit extreme haul, 3,356 cu. yds. | 230+50 | .60 | 240 |
| 231 | 295 | 10 | 5 | 200 | | 231+25 | 1.30 | 390 |
| +40 | 485 | 15 | 10 | 490 | | 231+70 | 1.80 | 882 |
| 232 | 880 | 25 | 5 | 900 | | 232+60 | 2.60 | 2340 |
| 233 | 1200 | 30 | ..... | 1230 | | 233+30 | 3.40 | 4182 |
| 233+60 | 800 | 25 | ..... | 775 | | ..... | ..... | ..... |
| Total..... | | | | | | | | 8036 |

*Embankment.* (The fourth column gives borrow instead of waste.)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 227 | 20 | ..... | ..... | 20 | 224 + 90 limit free haul, 417 cu. yds. | | | |
| 226 | 53 | ..... | 20 | 33 | | | | |
| +60 | 94 | ..... | ..... | 94 | | Haul betw. 224 + 90 and 224+45 | .45 | 267 |
| 225 | 204 | ..... | ..... | 204 | | | | |
| 224 | 580 | 120 | 40 | 660 | 224+90 | | | |
| +50 | 327 | ..... | ..... | 327 | 218 + 60 limit extreme haul, 3,356 cu. yds. | 223+75 | 1.15 | 376 |
| 223 | 335 | ..... | 15 | 370 | | 223+25 | 1.65 | 611 |
| 222 | 600 | ..... | ..... | 600 | | 222+50 | 2.40 | 1440 |
| +40 | 270 | ..... | ..... | 270 | | 221+70 | 3.20 | 864 |
| 221 | 200 | ..... | ..... | 200 | | 221+20 | 3.70 | 740 |
| 220 | 285 | ..... | ..... | 285 | | 220+50 | 4.40 | 1254 |
| 219 | 410 | ..... | ..... | 410 | | 219+50 | 5.40 | 2214 |
| 218 | 750 | ..... | ..... | 750 | 218+60 | 218+80 | 6.10 | 1830 |
| 217 | 800 | ..... | ..... | 800 | | ..... | ..... | ..... |
| Total..... | | | | | | | | 9306 |
| Total overhaul..... | | | | | | | | 17,632 |

This is assuming that the center of gravity is at the center of the prismoid, which ordinarily is close enough, though in some cases it is better to get it nearer by taking it at the center of yards. After getting the overhaul in the excavation by multiplying the number of yards between each station, or plus, by its average distance hauled we go through the same process with the embankment, and the sum of the two will give the total overhaul.

It seems as if this method was shorter and just as nearly accurate as the one in ENGINEERING NEWS of Jan. 31.

W. E. WESTON.

[We can hardly agree with our correspondent that his method is the simpler, all things considered, especially when there are a series of cuts and fills with overhaul; but ideas and tastes will differ.—ED. ENG. NEWS.]

## A Brooklyn Bridge Suggestion.

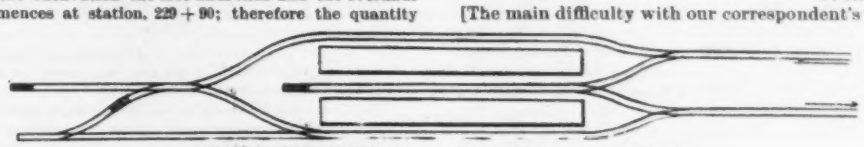
NEW YORK, Feb. 28, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have been watching your discussion of the Brooklyn Bridge problem with considerable interest. I am not a railroad man in any sense of the word, so please pardon my question: Why would not the arrangement of the tracks shown in the accompanying cut handle as many cars as either of the systems that have been proposed? Would it bring in any new elements of danger?

F. M. T.

[The main difficulty with our correspondent's plan



A SUGGESTED TERMINAL FOR BROOKLYN BRIDGE.

is that there is not time to run the train into the central slip, load and unload, stop and start, and clear the frog again in 90 seconds; yet, on the whole, this is the best switching plan yet suggested. It is certainly better and safer than the plan lately recommended, in the following respects: 1. It eliminates the rear grade crossing of the two systems of track, which alone makes less than a 60-second headway practically impossible. 2. It gives two engines to each train for the tail-switching process, without which even the present switching movements cannot be made on time, much less any quicker movements. But, on the other hand, this plan, which is a combination of the so-called "tail-switching" and "head-house" system, retains the objectionable feature of a grade crossing, in effect, at the gantlet junction, in front of each platform. We do not recall having seen before just the combination suggested. It is as good as any of them; but, as such, it is merely another illustration of the truth which we have repeatedly stated—that it does not lie within the wit of man to materially increase the capacity of the present terminals by any switching combinations whatsoever. The utmost possible increase which can ever be realized in practice by any switching plan, our readers will find by watching the course of events to be about what we have already stated, somewhat under 50%. What does that amount to? The cars now run in the most crowded hours with 120 passengers per car, about one-third seated, and two-thirds standing. Adding 50% more cars per hour merely reduces this load to 80 passengers per car, half seated and half standing, without allowing for any increase of traffic. But the traffic is now throttled by lack of capacity, and will immediately expand 50% if given the chance, so that if the trustees really carry out their now proposed plan their last state will be worse than the first from the very beginning; the crowd per car will be about the same, and the crowd in the station and its approaches will be 50% greater. The question of "more capacity" will then at once be up again, and more rational and honest treatment of the problem, we may reasonably hope, will then be insisted on.]—ED. ENG. NEWS.

## Cement Tests.

IOWA CITY, Ia., March 4, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I send by this mail a broken briquette of "Buckeye Portland cement." The briquette is a fair sample of my machine-made briquettes, but is above the average in the regularity with which it broke. It was 8 mos. old-neat, unsifted, and had been immersed in water the whole time. Tensile strength, 1,280 lbs. I am now using the new Richle's rubber buffer clips, and only about 10% of the briquettes break elsewhere than in the minimum section, against 50 or 60% with the old clips. I ordered the new clips the day I received the copy of ENGINEERING NEWS containing the description of them, and have broken about 500 briquettes to date. In your description of my briquette machine you suggest that the St. Louis jigger might be used with advantage. I had already tried it, and the results were not in any way satisfactory. I am just completing the plans for a mixer and briquette machine combined, to be run by power.

C. D. JAMESON,
Prof. C. E. State Univ. of Iowa.

[The briquette of Buckeye Portland cement is certainly a remarkably fine sample, in every respect.—ED. ENG. NEWS.]

HANOVER, N. H., March 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The following cement tests may be of interest to some of your readers: Cement used, "Newark Rosendale"; proportions, 3 parts cement, 1 part water, age of briquettes, 3 years. The rather incoherent paste was thoroughly tamped into the molds. Temperature of mixing room, 45° to 50° F.; temperature of mixing water, 72°; temperature of immersion water, 42°; temperature after leaving water,

45° to 80°; hours in mold, 4; hours in water, 50. Nine specimens were tested, giving 634, 734, 898, 620, 763, 997, 895, 867 and 784 lbs. per sq. in. Mean, 799 lbs. per sq. in. No. 4 broke by shock. Omitting No. 4, the mean would be 822 lbs. per sq. in. All specimens (except the last) broke at the clips. There were only nine briquettes tested.

Very truly,

HIRAM A. HITCHCOCK,
Prof. C. E. Thayer Sch. C. E.

[Is our correspondent using the right sort of clips as set forth in recent issues of ENGINEERING NEWS? —Ed. ENG. NEWS.]

## "Road Making and Maintenance"—A Charge of Plagiarism.

PHILADELPHIA, March 4, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The above caption, as published in your issue of Feb. 28, is readily misunderstood to mean that the plagiarism complained of is in the book whose correct title is "A Move for Better Roads," and implies a charge against the Secretary in publishing matter which appears to have been stolen from another author.

It it but just, therefore, to state that, in the absence of evidence to the contrary, we were bound to assume that the contributors were honest in their intentions and had complied with the conditions of the competition requiring "original [matter], not compilations."

Moreover, although the preliminary report of the Engineers' Society of Western Pennsylvania antedates the reception of our paper, there was no evidence before the committee that the contributor No. 15 might not have been the same person who prepared or assisted in preparing that report, and with whom the portion used in his contribution to the prize papers may have been original and hence legitimate matter.

Since no names are given for these abtracts, we do not see that any injury has been done to any one, as the writer might as readily be assumed to be a member of the Western Society as any other individual, and the abstracts printed in our book do not cover two pages.

If any one was imposed upon, therefore, it was our committee and not our patrons, and it was with sincere regret that we learned that some one had perpetrated so serious a fraud upon us.

We trust he is not a member of the profession, since it seemed to be necessary for him to supplement his own ideas by appropriating so extensively the labor of others without acknowledgment or compensation.

We do not desire to condone the fraud, and trust that the publicity given to the matter by its publication will have a good moral effect in deterring others from similar attempts.

LEWIS M. HAUPT.

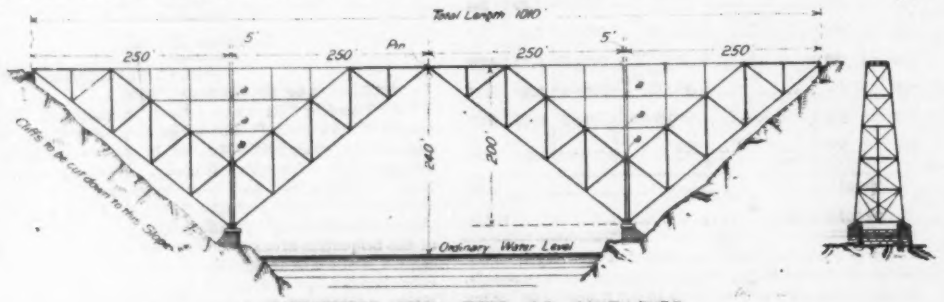
## A New Type of Hinged Arch.

DETROIT, Mich., March 4, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I inclose herewith a sketch showing the outline for a 500-ft.-span three-hinge arch to be erected on the cantilever principle. The design is the result of several years' study to circumvent the objections to the ordinary cantilever type, and is especially applicable to the crossing of the Niagara River. Would you be so kind as to publish this for me? I want to invite a discussion as to the merits of my plan, and your paper presents the best means for doing this. My claims for this design are as follows: It embodies simplicity with absolute economy, as the loads, both vertical and horizontal, travel to their reactions by the shortest routes. The excessive deflections, the continual reversal of strains, and the consequent mechanical difficulties which are found in the cantilever bridge are entirely done away with. It should be borne in mind that the design is applicable to deep gorges only, and should not be compared with cantilever bridges in general. Sincerely yours, J. W. SCHAUB,

Eng'r. Detroit Bridge & I. Works.




A SUGGESTED NEW TYPE OF CANTILEVER.

[This design bears a general resemblance to the proposed Viaur viaduct in France (ENG. NEWS, Nov. 30, 1889), which latter, however, is much the more graceful structure in its outlines, and, as it appears to us without making computations, little, if any, more expensive in the quantity of material required; but this impression is perhaps erroneous.—ED. ENG. NEWS.]

## Civil Engineer Peary's Expedition to Greenland.

*U. S. Navy Yard,*
LEAGUE ISLAND, Pa., March 10, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your last issue I notice a personal which states that I am going to the North Pole, "as will be seen in another column." I do not see any further reference to the matter, but beg to say that my object is not the attainment of the North Pole, but the determination of the northern limit of Greenland, and the study of glacial action in that locality. R. E. PEARY, U. S. N.

[The article to be seen "in another column" appears in this issue, and was crowded out of our last. Our reference to the "North Pole" was merely a semi-jovial expression of belief that Mr. PEARY would "get there" if any one could, which was intended to be accompanied by a more detailed explanation of his exact purpose. Mr. PEARY will carry with him the earnest good wishes of all engineers for success in his perilous expedition.—ED. ENG. NEWS.]

## Rapid Transit in Boston.

An address was given March 2 by Mr. H. C. SPAULDING, under the auspices of the new Board of Trade of Lynn, upon the rapid or swift transit problem as applied to Boston and its suburbs. Mr. SPAULDING may be remembered as having advocated some years since a plan by which our railway systems should be extended to the northern headlands of the coast, and under the united action of the United States, England and Canada a rapid transit line could be established for commercial purposes between this country and Europe which would require but four days' time in crossing the Atlantic.

Mr. SPAULDING is now making application to the Massachusetts Legislature for a franchise for the Boston Ry. Co., an outline of the proposed plan for which was given. When population has reached a certain point in concentration united or municipal action is necessary for the best good of the whole, such as the establishment of waterworks, or a supply of gas for lighting or heating.

Rapid transit is one of those important matters which has been recognized as such in New York by the appointment of a Rapid Transit Commission, and the appointment of a commission in Boston is now pending. The term rapid transit is defined as the method by which the suburban populations are moved at a speed a little greater than the old accommodation, or local, train service. It comprises the group of steam, electric and cable roads and the elevated systems of New York and Brooklyn. The steam railways move heavier loads and larger numbers at a time and in larger cars than any of these so-called rapid-transit lines.

In distinction from this he defined swift transit to be the moving of loads such as our steam railways carry at 40 to 60 miles per hour, instead of at the present average speeds of from 10 to 20 miles. The greatest and only serious obstacle to running at twice the speed and saving half the time now required is the existence of grade crossings. Boston municipality has a population of 648,000, but immediately surrounding the city, within a radius of 10 or 12 miles, or 15 minutes' ride by swift transit, are 33 independent towns and municipalities, with one to two millions of population, comprising greater Boston, which have at present practically no communication with each other and no possibility of unity of action. The inhabitants of Dedham or Brookline or Newton, within 15 to 19 miles of Lynn and the North Shore, might as well be in Fall River or Worcester or Hartford so far as the possibility of either social intercourse or business relations are concerned, owing solely to the difficulty of crossing Boston and the time and annoyance caused in transit, which is practically prohibitive.

To remedy this and to utilize large tracts of suburban districts close to the city for manufacturing which are not now utilized solely because of these difficulties, a tunnel system is proposed with double tracks and connecting with all the present surface steam railroads centering in Boston. The tunnel would continue the northern roads, such as the Boston & Maine, in a direct line to the heart of the city. The approach would begin at about the central point of East Boston, thence by tunnel under the harbor about 60 feet below low water to the old peninsula of Boston. Stations which indicate the general course of the tunnel would be located at East Boston, in Boston near the ferries, at Scolley's Sq., another near State St., at Summer St. and at the Albany and Old Colony stations. The plan contemplates a union station eventually for all the railways of Boston, situated probably upon the Back Bay at Huntington Ave. The great advantages of such a scheme in the saving of annoyance to travelers passing through Boston, as well as to the local traffic, and the economy of maintenance, compared with the eight or nine terminals on valuable land now required by the different railway companies, and the improvement in freight facilities and transfer are apparent. By this plan through trains could be run from Canada or Portland or Bar Harbor directly through Boston to New York and all other points south or west. The ideal arrangement for the suburban traffice is the loop line, or figure 8, which could supply the means of transit to every district about Boston, the necks of the loops being the tunnel in the center of Boston. The idea is that of the inner and outer circles first developed in the London underground railways.

As to the cost of this tunnel it was stated that the great St. Clair tunnel cost, with approaches, $1,150,000 per mile, for single track; the Thames River tunnel £775,000 for 1¼ miles, or, for double track, with equipment, stations and lifts, $1,100,000 per mile.

The Boston tunnel would be in a bed of clay which is from 60 to 80 ft. thick, and ought to be built for $1,000,000 per mile. The amount of tunneling to unite all the railways as proposed would be about 5 miles, and the cost would therefore be about $5,000,000. Now, what is the traffic to support such a scheme. The present passenger traffic in and out of Boston upon the steam railways is 48,000,000 annually, or about 150,000 every week day. The ferries carry 15,000,000 more, or the total present passenger movement is 63,000,000 annually. Leaving entirely out of the account the merchandise traffic, it was stated that a royalty of 1 cent per passenger would give an income of $650,000 a year, or more than 10% on the five-million expenditure required. The truth that improved facilities create new traffic was illustrated by the experience of the New York street railways. The elevated railway relieved the street cars of the unprofitable long-distance travel, and the street railways made more money (instead of less, as was expected), because of the fact that it made room in the cars for more short-distance passengers, and each car was filled several times in making a single trip, and thus took in more fares than when they had been principally filled by the long-distance traffic.

The new line would have 7 connecting stations to different sections of the suburbs and 10 suburban stations, or 17 in all. The tunnel stations would be provided with passenger lifts, taking 50 and 100 passengers each at once and bringing them to the street level in about 15 seconds' time. The proposed plan would better utilize 130 miles of suburban tracks now built, and which are capable of carrying ten times the present traffic. It is stagnation that kills, causes suffering and prevents progress. Competition has great advantages as a stimulant, and increase sefficiency and economy in the transaction of every business. There are 1,000 trains a day now moving in and out of Boston. With the connections contemplated it is entirely probable that 75,000,000 will be carried in the near future, without the addition of another track, by the steam railways of Boston.

## Keeping Notes for Preliminary Surveys.

BY PROF. WM. G. RAYMOND, UNIV. CAL.

To any one who has had to decipher the notes of a number of field parties, the value of any one organization of a uniform system for the keeping of all field notes need not be stated. During the past year the writer has adopted the following form for preliminary surveys as the result of some ten years experience in the field, the office and the class room, during which period he has tried almost every method he has seen advocated. The form herewith presented seems to him to be the best for simplicity, rapidity and accuracy both in field and office.

The form of note book shown below is self-explanatory:

[Description of line here.] 34

| Station. | Angle. | Azimuth. | Mag. Az. | Lat. | Dep. | Total. Lat. | Total. Dep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

As it is not expected that topography will be taken in the transit book, no space is left for it. For the same reason, it makes little difference whether the notes are recorded up or down the page. [We question this; notes should be recorded up the page.—ED.] If it is thought desirable to take topography in the transit book, the columns for total latitude and departure may be omitted. The writer believes in the use of azimuth instead of bearings, as affording simpler and quicker work in the field, there being no possible confusion as to quadrants, and he also has the telescope transited and the deflection angle measured in the ordinary way, when, in order to determine the azimuth of the new course, it is only necessary to make a simple addition or subtraction,

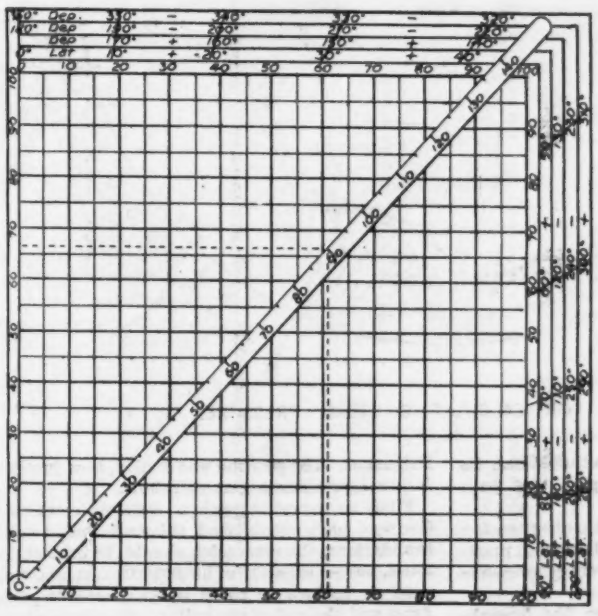


DIAGRAM FOR COMPUTING LATITUDES AND DEPARTURES.

according as the angle is right or left. Of course the reverse process may be employed by those who prefer it, viz.: carrying the azimuth, the telescope never being transited, and computing the angle. In railroad work it is necessary to know the deflection angles.

If the compass box is not graduated consecutively from 0° to 360°, a narrow paper ring, graduated to 5°, is pasted on the glass to enable the eye to catch quickly the degree; the needle azimuth is then read as closely as may be desired on the engraved circle. With an instrument having its plates graduated to 20 minutes and reading to 30 seconds the writer's transitmen have frequently detected errors of 20 minutes in the reading of the plates. It is not necessary to start with either the north or south point as zero azimuth, though it is doubtless well to do so, taking either true or magnetic meridian at pleasure. The writer almost always uses the magnetic

There seems to be but one serious objection that can be raised against this method, viz.: With the ordinary form of trigometer and tables the bearing would have to be found to facilitate the computing of latitudes and departures for platting. This difficulty is obviated by JOHNSON'S tables or by the form of trigometer devised by the writer, and herewith shown in Fig. 1, the use of which is evident. There are, of course, minor graduations not shown.

[The device for computing latitudes and departures (why it should be called a "trigometer" we cannot see) has probably been independently reinvented dozens of times. It is a truly excellent device, but the writer knew it and used it many years ago. It furnishes the only rational way of computing latitudes and departures for railway surveys, and is amply accurate. It should be constructed with a sheet of accurately engraved cross-section paper as a foundation. We do not believe in working by true azimuths at all, but always by magnetic azimuths. Set the zero of the plates on the magnetic north in starting the survey, and never reset. Then the vernier and the needle readings will always check each other when the telescope is set on a sight.—ED. ENG. NEWS.]

## Decomposed Granitic Sand Used as a Natural Mortar in Japan.

A much decomposed granitic sand is found in several provinces of Japan which, when mixed with slaked lime, becomes as hard as the puzzolana and trass of Europe. The following description is taken from a paper by Dr. J. TAKAYAMA, translated in the "Abstracts" of the Institution of Civil Engineers, Vol. CIII.:

This sand has been used for an unknown period for wells, fountains, etc. The author tested seven varieties of the sand to find the best proportions of sand and lime. Three of them were found upon decomposed granite, and four had been transported by natural agencies to a distance of several miles from the nearest granite. When the first lot was sifted, the coarse or gritty particles failed to set when mixed with lime. The fine portion, about 3% to 26%, made a yellowish powder, which, when mixed with lime, hardened like natural volcanic tufa. The percentage of silica in the sand ranged from 44% to 53%; the greater part of the remainder was alumina, and the author attributes the property of hardening with lime to the formation of aluminates and silicates of lime.

When tested for tensile strength, the two proportions of 10.24 parts and 20.48 parts of lime added to 100 parts of the sand gave the best results. Calling these specimens Nos. 3 and 4 in the five proportions tested, the following table may be made:

| Conditions of test. | In air. No. 3. lbs. | In air. No. 4. lbs. | In water. No. 3. lbs. | In water. No. 4. lbs. |
|---|---|---|---|---|
| After 2 weeks (per sq. in.) | 56.89 | 55.18 | 74.50 | 55.75 |
| " 15 " " " | 85.76 | 76.50 | 111.65 | 77.23 |

Later tests with 100 parts sand and 15.03 parts of slaked lime gave still higher results; or a tensile strength of 118.9 lbs. per sq. in. in 12 weeks. This slightly diminished during the succeeding 3 weeks. The best results were obtained from briquettes hardening under water. Experiments proved that these briquettes would disintegrate after an immersion of 18 weeks in salt water.

## Pavements at St. Louis, Mo.

The following matter relating to pavements was compiled by Mr. THOMAS H. MACKLIND, District Engineer in charge of reconstruction. With the exception of the section on brick pavements, kindly sent us by Mr. MACKLIND, it is reprinted from the *Engineering Record*:

In reply to inquiries from a number of cities and towns for details of the pavements of St. Louis, Mo., Mr. THOMAS MACKLIND, District Engineer in charge of reconstruction, has supplied the following information, the pavements being rated in the order named:

GRANITE PAVEMENT.

For manufactory and mercantile traffic, granite set on a base of hydraulic cement concrete 8 ins. deep, 2 ins. sand cushion; stone 7½ ins. to 8¼ ins. deep, 3½ to 4½ ins. wide and 8 ins. to 12 ins. in length.

Cost in St. Louis in 1890, 37 to 42 cts. per sq. ft. complete in place, exclusive of curb; curb costs 70 to 90 cts. per foot, lineal.

This form of pavement has been down 17 years, under a traffic of 6,000 teams per day of 12 hours; width of roadway, 50 ft. between curbs; cross-section camber, 0.60; cost of maintenance, ¼ ct. per square foot per annum.

Cleaned by horse sweepers; cost per 10,000 sq. ft. swept, 50 cents; swept three times a week; to sweep 10,000 sq. ft. by hand costs from $1 to $2.50.

Two-horse wagons on 3 or 4-in. tires, loaded, average 7,300 lbs.; team, 2,400 lbs.; wagons for hauling railway cables and machinery weigh 9,700 lbs.; width of tires, 14 ins.; load, 97,000 to 100,000 lbs., drawn by 40 horses; horses average 1,400 lbs.

ASPHALT PAVEMENT.

This roadway, laid on Pine St. by the Barber Asphalt Co., in 1883, is now in good condition after a test of 8 years, under a mixed traffic of 3,000 vehicles, in 12 hours, from 7 A. M. to 7 P. M. The work was carefully executed, and consists of a 6 in. hydraulic cement concrete base, ½-in. cushion coat, and 2-in. surface of wearing coat; cross-section camber, 0.50; width between curbs, 36 ft. Traffic is what may be termed building materials, residence supplies and suburban; while it has been subjected to the heaviest loads hauled in the city with fair results, it must stand below granite for wear. Cost, 33 cts. per square foot.

Maintenance under contract, 1 ct. per square foot per annum, in the case of the roadway cited; maintenance under later contracts, ½ ct. per square foot per annum. The maintenance clause in contracts runs for 10 years, the first year at the cost of the contractor.

This form of pavement as laid here, all points considered, stands in the front rank under the conditions indicated.

TELFORD PAVEMENT.

This form of pavement, as laid on Lindell Ave., consists of a base course of random stone, set broadest face down, in lines at right angles with the street, 8 ins. in depth, finished by wedging spawls into the open spaces, and breaking down the points to a uniform surface, then placing a 6-in. course of clean macadam; this is thoroughly rolled by a 10,000-lb. 4-horse roller, 5 ft. in diameter and 5 ft. face.

The surface is then finished with 2 ins. of cement gravel, rolled, then 2 ins. coarse clean gravel, well wetted down and thoroughly rolled to a compact, smooth surface. This avenue is 60 ft. between curbs; cross-section camber equals 0.80; average grade, 1%; cost, complete, exclusive of curb, 12 cts. per square foot.

The traffic, as observed in 1890, was 1,500 vehicles in 10 hours, 65% being one-horse vehicles, 15% two-horse vehicles (on springs), and 30% two-horse wagons hauling dirt, building material, coal, etc. In 1890 the repairs on this avenue of 469,50) sq. ft. cost ½ ct. per square foot. Our macadam pavements are finished on the top in the same manner as Telford, cost 9 cts. per square foot, and, for a traffic of from 100 to 500 vehicles per day, does fairly well. Cost to maintain a macadam pavement under a traffic of 3,200 vehicles in 12 hours, on a 34-ft. wheelway on Broadway, 4 cts. per square foot per annum; has been reconstructed with granite.

WOODEN PAVEMENT.

This pavement has been in use, in a limited way (10 miles), from 1860 to 1882, laid under the Nicolson patents. The average life during that period was six years and three months.

Broadway, 50 ft. between curbs, under a commercial tonnage of 2,500 vehicles in 12 hours, cost 4¼ cts. per square foot per annum. The wood used was cottonwood, burnettized. Decay began to develop from the third to the fourth year.

There were a few exceptions on Third St., traffic 2,400 vehicles in 12 hours, where, with repairs, a 6-in. block of prepared cottonwood wore down to 1⅛ ins. in 7 years; width of wheelway, 28 ft.; grade, 1%. All of this pavement was set on inch boards; average cost, 42 cts. per square foot; 6 cts. per square foot per annum without repairs; replaced with granite. Since 1884 the practice has been to set the blocks on a 6-in. hydraulic cement concrete base, the channels filled with hot bituminous composition. The channels are formed by iron studs driven in the side of the blocks to the head, which is half an inch. The blocks are treated with chloride of zinc.

This work costs: Sweet gum, 35 cts.; white pine, 37½ cts. to 41½ cents per square foot. Maintenance under a 10 years' contract, half a cent per square foot. Decay set in, in this work, at the close of the third year. From the present appearance of these streets, the conditions being the same, the record of wood block pavement will not be changed. In 1890 the first cedar (round) block pavement was laid on Olive St., west of Grand Ave., on a 6-in. concrete base; it has the merit of being cheap, costing 20 cts. per sq. ft. complete in place, exclusive of curbstone. It is expected to wear from 3 to 5 years, when it can be restored, say, at 7 or 8 cts. per sq. ft., or less, as the lumber market may change. Admitting it to last 5 years, it will cost 4 cts. per sq. ft. per annum minus repairs. Olive St., at the point indicated, has a mixed traffic of 900 vehicles in 12 hours. There is a double-track cable road also, which forces the traffic on straight lines, thus adding to the wear by adding a tendency to rut.

BRICK PAVEMENT.

From 1878 to 1881 experiments were made on Chestnut St., from Third to Fourth Sts., and on Second St., between Pine and Olive Sts. In 1883 this brick pavement was taken up, having failed, and replaced with granite.

Pavement on Chestnut St. was set on a 6-in. concrete base; traffic averaged about 1,200 vehicles in 12 hours. The pavement on Second St. was set on a sand base; traffic averaged about 1,500 vehicles in 12 hours. Width of wheelway on Chestnut St., 36 ft.; width on Second St., 25 ft.

The details of laying these pavements was carefully executed, but brick pavement for the streets of a commercial city are of doubtful utility. The prime difficulty so far as our experience has gone is the failure to produce a brick of uniform texture throughout, being at the same time tough and neither too hard nor too soft.

This difficulty will doubtless be overcome, in which event brick pavements for suburban towns and strictly residence districts in larger cities would give satisfaction at a moderate cost, say not to exceed 20 to 25 cts. per square foot laid complete in place.

Brick has been used in Holstein, Germany, for many years on surburban or county roads in the low, flat country, there being no other material at hand. It has given fair satisfaction, the traffic being very light, mostly farm wagons and carts; the horses are rarely shod.

Blows delivered upon the pavement by shod horses drawing commercial tonnage contribute the largest quota to the destruction of street surfaces.

It will be readily seen the adoption of a material for street pavements must depend upon the character of the traffic to which they may be subjected.

HOW PAID FOR.

All new work, except crosswalks and grading, is paid for by special tax assessed against the abutting property, based on the assessed value of the property per front foot, against which value per front foot bills are issued to the amount of 25%. The cost of the work in excess of 25% of taxable valuation per foot is paid by the city; reconstruction the same, except the grading, which is included in the tax bills.

CLEANING AND SPRINKLING.

To reduce the dust nuisance to a minimum in the spring, summer and autumn months is a difficult problem. The first step is to pave the streets, when the cost will not be too onerous on the property; the second is to clean by sweeping, or such other method as will be efficient and least injurious to the street surface in the operation.

Freezing, thawing and moisture are especially injurious to the streets or roadways. The destruction from freezing can be reduced to a minimum by perfect drainage, thus relieving the surface of the roadway from moisture by providing for its rapid discharge from the surface to a depth that will insure the general stability of the work. The mode of underdrainage, where needed, will be determined by the character of the sub-grade and other general conditions. One of the points in favor of the Telford foundation is the result of the numerous small openings in the base course of random stone, which act as drains (until silted up from any cause). They permit the rapid fall of the surface moisture to the sub-grade line and below.

It being a self-evident proposition that the drier the roadway the longer the life, and the more efficient the service, at the lowest cost of maintenance it remains to provide for the elimination of dust and mud from the problem of good streets. The first step in this direction is perfect cleaning, water being only used to dampen the dust or dirt, so as to allow being swept without smearing or the dust being thrown into the air by the motion of the broom. Water, aided by broom work, may be used to advantage under favorable conditions to clean granite and asphalt streets, they being practically water-tight. Sprinkling in excess of those purposes should only be employed to cool the streets in hot weather. All paved alleys, in the paved district, should be swept as often as needed to completely remove all dust and dirt, as the alleys contribute largely to the dust volume; also as a sanitary measure.

Telford and macadam streets can in many cases be swept to advantage during the dry summer months, as the dust when wet holds the moisture in the form of a mud plaster, to a serious injury of the street surface and consequent greater cost of maintenance.

## A Simple Steam Pressure Calculator.

BY WM. COX.

The accompanying diagram, an original design by the writer, is a species of circular slide rule by which the theoretical average pressure per square inch resulting from any possible cut-off and initial pressure can be instantly determined, or conversely, given any average pressure, the several combinations of cut-off and initial pressure which will produce it can be at once determined.

The diagram is not ready for use in its present form, as printed, however. To prepare it for use: Cut out the square space of blank paper on which the diagram appears, and mount it on a square piece of card-board. Then cut the central disk free very carefully, so that it may be an exact circle. Glue the outer part of the sheet to a second piece of card-board, and fasten the central disk to it by a pin

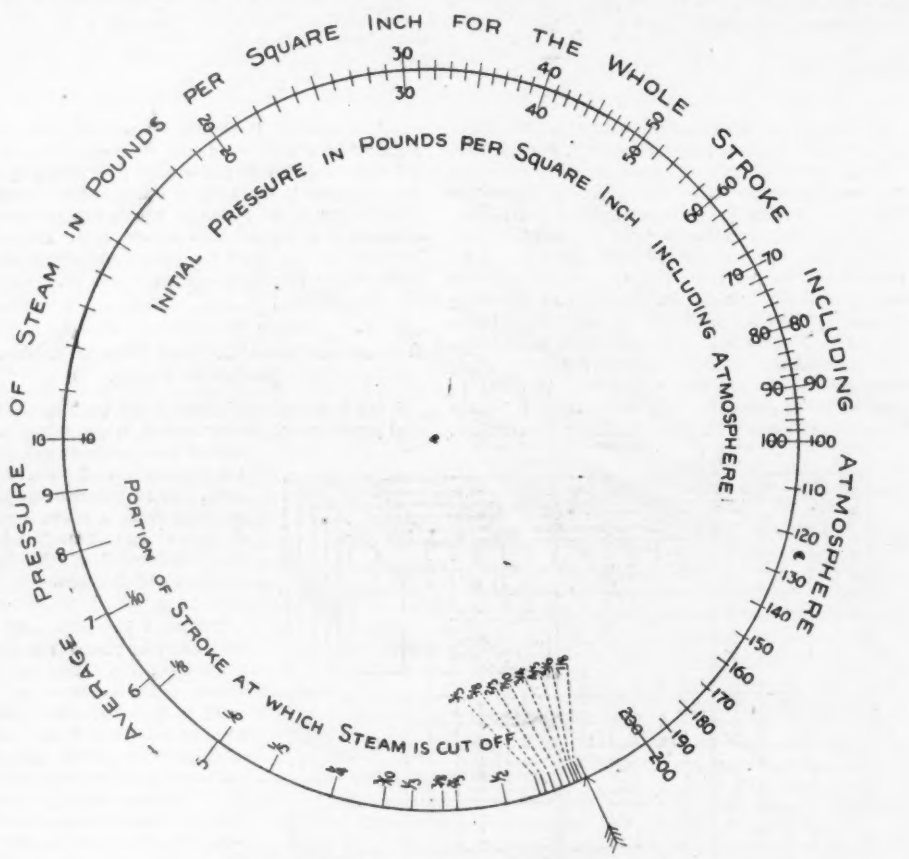

INITIAL PRESSURE IN POUNDS PER SQUARE INCH FOR THE WHOLE STROKE
INITIAL PRESSURE IN POUNDS PER SQUARE INCH INCLUDING ATMOSPHERE
AVERAGE PRESSURE OF STEAM IN POUNDS PER SQUARE INCH INCLUDING ATMOSPHERE
PORTION OF STROKE AT WHICH STEAM IS CUT OFF

DIAGRAM FOR CALCULATING STEAM PRESSURE.

passing exactly through its center so that it may be free to revolve within the outer part, and flush therewith.

When this is done, if any given ratio of expansion be set at the arrow, the diagram will show all possible combinations of initial and average pressure which can result from that ratio.

The diagram *N* indicator is based on the formula

$$p = P\frac{(1 + H)}{L} \times l \quad \text{or} \quad = P\frac{1 + H}{R}$$

where $L$ = Length of stroke in inches,

$l$ = Distance traveled by the piston before the steam is cut off.

$R$ = Ratio of expansion $= \frac{L}{l}$

$H$ = Hyperbolic logarithm of $R$.

$P$ = Initial pressure of steam in pounds per square inch, including atmosphere.

$p$ = Mean pressure during stroke in pounds per square inch, including atmosphere.

This formula is solved by the diagram at a single setting for all possible values of any of the variables.

To find the mean pressure: Set the "portion of stroke at which steam is cut off" $(l \div L)$ on the disk, to the arrow on the indicator; then, co-inciding with the "initial pressure of the steam" on the disk will be found the "mean pressure" on the indicator.

No allowance is made for imperfect vacuum.

## On the Inefficiency of Reservoirs to Prevent Inundations.*

Among the means pointed out by the careful study given during the past twenty years to the prevention of floods the construction of artificial reservoirs has taken a prominent position.

Such reservoirs were to be built, preferably in mountainous regions, and designed to delay the advance of any flood, diminishing the maximum flow by increasing the time of discharge, and so reducing the height of the flow. The French Government was petitioned (1881) by the inhabitants of the southern districts to construct such reservoirs in the Pyrenees and Cevennes to serve, not only in reducing the height of the floods in that part of France, but also to act as feeders to the canals, to furnish water power in the immediate vicinity, and to provide, as far as might be, for the needs of irrigation. The petition was denied, how justly the following considerations will show.

First, as regards capacity. Data collected on the Garonne have established the fact that, to avoid inundations, the reservoirs should, to protect Toulouse, have a capacity of 550,000,000 cu. m. and would need to be two or three times greater to protect Agen and the rest of the valley. By actual surveys and examinations it was found that in this valley 92 reservoirs could be constructed having a total capacity of 290,000,000 cu. m. and of these 92 only 12, with a capacity of 87,000,000 cu. m., would have an effect on the flood; or, the total useful storage possible in this valley would be one-sixth of that necessary to protect Toulouse. Similar conclusions have been reached from the study of other large rivers of France, where it was found that, using all possible sites for dams and reservoirs, a careful comparison of their capacity with the flood volume shows that the storage was entirely inadequate.

Second, the position of the reservoirs in mountainous districts does not insure protection for the lower part of the valley, where floods generally occur. The reservoirs are built in mountainous country, because topographically their construction is easier, and the rains are there generally heavier; but as happened on the Garonne in 1875, the extraordinary

*Translated from an article by Mr. GROS, Inspecteur des Ponts et Chaussée, in *Annals des Ponts et Chaussées*, II. 1881, and sent to this journal by Prof. H. N. OGDEN, of the College of Civil Engineering, Cornell University.

rains producing the floods occurred outside of the mountain rain zone, and reservoirs in the mountains would then have had no effect on the resulting flood lower down the valley.

Since the volume increases proportionately with the flow down stream, the influence of the reservoirs is continually being reduced. For example, a lowering of 2¾ ft. in the Rhone at Lyons caused, we will say, by reservoirs on the River Ain, and in the lakes of Geneva and Bourget, would mean a lowering of 1.3 ft. at the juncture with the Saone, and would be soon inappreciable. Similarly a reservoir of 100 million cu. m. capacity at Toulouse would in effect be equal to one of 50 at the mouth of the Iam, and of 40 at Agen, of 18 at Tourien, and the effect would be inappreciable at Langon.

From this may be seen the reduced influence of even the largest reservoirs, and the enormous sizes necessary to sensibly decrease the effect of the inundations which may threaten the centers of population in the lower parts of the valleys.

Since the maximum height of the water in the tributaries, in time of flood, is usually in advance of that in the main water courses, a delay in the discharge of the tributaries might add to the maximum discharge of the main stream and the amount of the flow, and consequently the intensity of the flood would be increased, instead of diminished and the influence of the reservoirs, instead of being advantageous, would be positively injurious. The effect, too, of one reservoir on another, the combined effect of the two on a third, and of all the reservoirs on the main stream, is very uncertain and almost impossible to foresee.

Successive floods or a series of floods separated only by a short interval, as in 1856 on the Garonne when, for more than two months, five successive floods kept the water high, can have but one effect with or without reservoirs. The second flood will find the reservoir full and the storage capacity having been reached, and if no dams or reservoirs give way, the ordinary full effect of the flood is produced. If a dam should give away the result would be many times more disastrous than that coming from the natural flood volume.

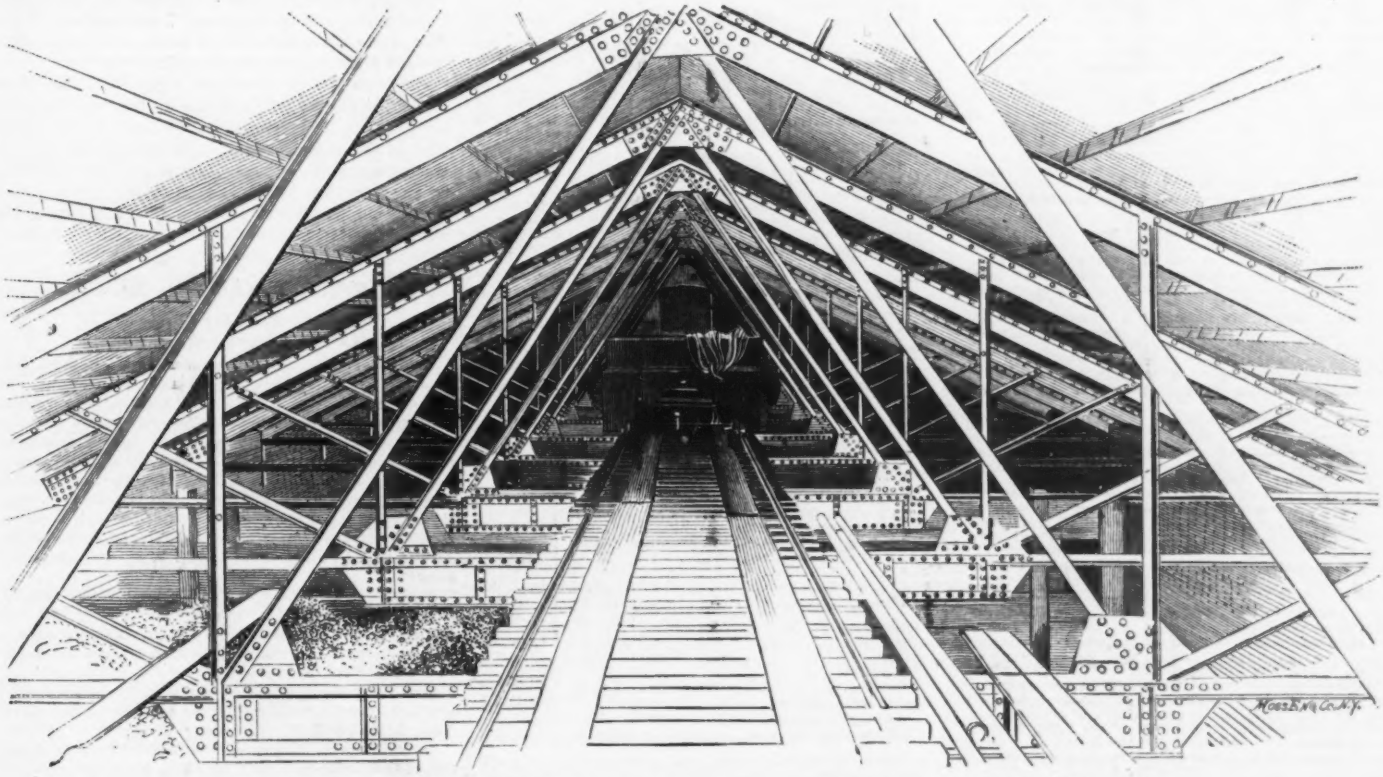
As to the possibility of using the reservoirs for feeding and irrigation purposes, the fact that they must be kept empty during the part of the year when floods may come is enough to set aside that use, for it is at that very time that the water would be most needed. Again, the method of distribution in the two cases is entirely different and would require a double set of gates for the two distinct purposes.

To sum up—the system of reservoirs employed to prevent dangerous floods in great rivers and to lower the height of inundations appears reasonable and very simple at first sight, but in the case of such rivers as the Garonne, the Rhone or the Po they present great difficulties and much uncertainty. In certain cases the establishment of such reservoirs would be more harmful than useful.

All things being considered, disasters like those caused up to the present time cannot be prevented nor their effect diminished by this means.

## A Peculiar Coal-Shed Roof.

The Burlington City Water-Works Co., of Burlington, Vt., is the owner of a coal-storage house, here illustrated in part, that will be interesting to water-works companies generally. The weather in that locality necessitates the storage of large quantities of coal, as navigation is suspended from about Nov. 1 of one year to April of the succeeding year. Under these conditions economy and convenience in handling this coal were essential features in planning the storage-house.



ROOF OF COAL STORAGE HOUSE OF THE CITY WATER-WORKS CO., BURLINGTON, VT.

The building used was designed and built for the company by the Berlin Iron Bridge Co., of East Berlin, Conn. It is located about 100 feet from the dock, and the coal is hoisted from the boats to a trestlework, on which the coal is weighed on an ordinary Fairbanks scale. This trestle connects with the building on the line of the lower chord of the roof, and the track is continuous with the track suspended from the roof truss, as shown in our illustration. The walls of the storage-house are brick; the roof trusses are made of iron; with iron purlins covered with corrugated iron; and the only wood used in construction is in the ties on the track.

The advantages of this design are that the coal is moved into the storage bins with but one handling; and, as it is dumped from the extreme height, the coal is distributed well over the floor, without the usual third handling. The illustration here given is taken from the entrance track in the gable end of the building, and shows the interior of the roof, the roof trusses, and the track. The general construction is sufficiently plain without further description.

## The Clarence Bridge at Cardiff, England.

This bridge, which crosses the River Taff, Cardiff, is illustrated and described in *Engineering* of Feb. 13. The bridge is made up of a central swinging span of 190 ft. 8 ins., with two openings of 72 ft. each, and two fixed end spans of 132 ft. each. Total length, 464 feet. The river bed, at the site of the bridge, consists of a stratum of gravel 32 ft. thick, overlying a deposit of marl; mud covers the gravel where the current is not too strong.

The abutment foundations were carried down 6 ft. and the pier foundations 12 ft. below the lowest point in the river bed. For the abutments, close timbered dams were used, and iron caissons for the piers, sunk by excavating from the inside.

The pier caisson was made of wrought iron, was 2 ft. wide in the skin, and braced diagonally every 4 ft. The cutting edge, or shoe, was also of wrought iron, and 2 ft. wide by 3 ft. 10 ins. high. This caisson had rounded ends and was 10 ft. wide from out to out, as near as the drawings can be understood. In constructing these caissons, guide piles were driven around the site of the pier, braced together and a platform laid down, upon which the caisson was riveted together. This being done, the caisson was raised slightly by long screws with capstan nuts, operating from a platform above; the platform was removed and the caisson sunk by the same screws to the river bed. Concrete was then filled in between the inner and outer skin or the caisson, and the dredge put to work for excavating the material inside.

A ring of masonry was built upon the iron caisson as the sinking proceeded, and when the required depth was reached the bottom was carefully leveled and the whole interior of caisson and masonry shell was filled with cement concrete. In the case of the central pier for the swinging span, a test load of 1,000 tons of iron rails was placed upon it after it was completed. This load was 30% in excess of the calculated maximum weight that the pier had to support, and the mass sunk only $\frac{1}{16}$ ins. under the test load.

The superstructure is made of mild steel, and in design is a pin connected truss, very American in its type, with buckle plate floor and wrought-iron parapets. An interesting fact in connection with the manufacturing of the steel eye-bars, says *Engineering*, is that the builders "found it more convenient" to have the heads forged on them in

America, the bars being shipped direct from the rolling mills in Glasgow to New York and back by way of Liverpool. Mr. W. HARPUR, the engineer of Cardiff bridge, has introduced the same form of eye-bar into the roof trusses for the St. Mary Street market house in Cardiff with marked success. It might be mentioned in this connection that the eyes of the tension members of the Hawkesbury bridge were also forged in the United States.

## Legal Decisions of Interest to Engineers.

*Claiming Rights of Way by Contract.*—Where a railway company employs a contractor to clear off and burn the rubbish from its right of way, the right of recovery against the railroad of one whose property is damaged from such fire is unaffected by the fact that the burning was carelessly done, but depends upon whether burning the rubbish was, under the circumstances, dangerous to the property of adjoining proprietors even if carefully performed. (St. Louis, I. M. & S. Ry. Co. v. Yonley, Sup. Crt. of Arkansas, 14 S. W. Rep., 799.)

*Construction of Culvert.*—Where a passenger on a railway train is injured because of a washout in the track at a place where a stream ran under a culvert, the fact that the culvert gave way because a dam above it, over which the company had no control broke, will not prevent recovery by the passenger for his injuries, if the manner in which the culvert was constructed in any way contributed to the washout, or made it worse than it would have been had the culvert been properly constructed. (Bonner v. Wingate, Sup. Crt. of Texas, 14 S. W. Rep., 790.)

*Liability of City for Defective Bridge.*—A bridge built by a private citizen with lumber furnished by the city, which forms part of a sidewalk of a platted city street, is used daily by the public as a public highway, and the city is responsible for personal injuries sustained by reason of its becoming and remaining covered with ice. A verdict for $3,500 in favor of a woman who suffered a permanent injury of the hip by an accident as a result of the condition of the bridge, together with a permanent shortening of the leg and other injuries of a permanent nature, is not excessive. (McDonald v. City of Ashland, Supr. Ct. Wis., 47 N. W. Rep., 434.)

*Responsibility of City for Sidewalks.*—A city or village which has the power to repair, or cause to be repaired, the sidewalks of its streets, if it has the means at its command to put such power into operation, is liable for injuries sustained by reason of defective sidewalks or obstructions therein of which its proper officers has notice or actual knowledge. This notice or knowledge must be proved, and evidence that during two previous years resolutions had been passed regarding the defects in question is enough to show actual knowledge by the municipality of the necessity for repairs. (Thompson v. Village of Quincy, Supr. Ct. of Michigan, 47 N. W. Rep., 115.)

*Liability of Owner for Defective Sidewalk.*—Where the charter of a city makes it the duty of the owners of lots to keep the sidewalks in front of them in good repair, and further provided that if they failed or neglected to do so the superintendent of streets should do so and the expense thereof should be charged against the lot so improved, the owner is liable to one injured by reason of a defective sidewalk, either to such person or to the city after it has been compelled to pay such damages, as it was the duty of the city to keep such walks in repair and collect the expense thereof from the owner, and that is the limit of the latter's liability. (City of Rochester v. Campbell, Court of Appeals of New York, 25 N. E. Rep., 937.)

*Competitive Bids for Public Improvements.*—Where the charter of a city provides that the Board of Public Works shall estimate the cost of any proposed public improvements, prepare specifications and let the work to the lowest bidder, the use of the term "lowest bidder" implies the necessity of competitive bidding, and a further provision of the charter empowering the Common Council to direct an additional assessment where a greater sum has been expended in the completion of an improvement than was originally estimated by the Board of Public Works will not authorize the council to add to a street grading contract another contract for paving the gutters on such street, thereby materially increasing the cost of the work over the estimate of the Board of Public Works and over the original contract price, without submitting that portion of the works so added to competitive bidding. (Ely v. City of Grand Rapids, Supr. Ct., Mich., 47 N. W. Rep., 447.)

*Construction of Contract as to Extra Work.*—A contract for the construction of a bridge in a village set out the estimated quantities of earth and rock excavation, and of brick and stone masonry. It stipulated that the quantities were estimated only, and that contractors should verify them, as the board of trustees did not hold themselves absolutely bound by them. Another clause stipulated that all necessary extra work or additional material not specified in the contract should be agreed upon, and the price established by the superintendent and contractor. The estimate proved to be greatly less than the work required, and the contractors claimed that all work in excess of the estimate was extra, which should be paid for under the clause relating to extra work, and not at the agreed price. Under such a contract extra work of the same character as that specified should be paid for at the contract price. (Sullivan v. Village of Sing Sing, Court of Appeals, N. Y., 25 N. E. Rep. 366.)

*Liability of City for Negligence of Contractor.*—A bridge in a city being out of repair, one of the aldermen who was a member of the street committee employed a firm to make the necessary repairs, no directions whatever being given as to the means by which the work was to be accomplished. Owing to the negligence of the persons employed by the firm, the bridge fell, and plaintiff, who was crossing it, was injured. The relation of master and servant did not exist between the city and the firm, or between the city and the persons employed by the firm, and the city was not liable. In the absence of notice, either actual or constructive, that the bridge had or was about to become unsafe, a claim that the city was negligent in not preventing the use of the bridge by passengers was without merit. In an action for personal injuries it is an error to charge that plaintiff is entitled to recover the value of time lost by reason of the accident, where there is no evidence that he was engaged in any particular pursuit, or enabled to earn any particular wages. (Wood v. City of Watertown, Supr. Ct., N. Y., 11 N. Y. Supp., 864.)

## Four Years' Changes in the Shipping of the Great Lakes.

An interesting and striking census bulletin (No. 23) exhibits the remarkable changes which have taken place in the shipping of the Great Lakes within the brief period of 4 years, 1886-90, as set forth in the following table, which we have constructed by combining several of those given in the bulletin, and which tells its own tale, without much comment. We add also, in Tables II. and III., computations of the percentages of increase and of the comparative values per ton shown in table I.

TABLE I.—CHANGES OF FOUR YEARS IN NUMBER OF VESSELS, TONNAGE AND VALUATION, ON THE GREAT LAKES, 1886-1890.

| CLASSIFICATION OF VESSELS. | Number. | | Net tonnage. | | Valuation, 000 omitted. | |
|---|---|---|---|---|---|---|
| | 1886 | 1890 | 1886 | 1890 | 1886 | 1890 |
| Total | 1,937 | 2,055 | 634,652 | 826,360 | $30,597 | 58,128 |
| *A—Structure:* | | | | | | |
| Side-wheel steamers | 43 | 42 | 14,150 | 16,949 | 1,494 | 2,209 |
| Propellers under 1,000 tons | 235 | 431 | 177,402 | 154,232 | 9,475 | 13,906 |
| Propellers, 1,000 to 1,500 tons | 72 | 122 | 86,728 | 151,611 | 5,935 | 11,804 |
| Propellers over 1,500 tons | 21 | 110 | 34,868 | 188,390 | 2 645 | 17,738 |
| Tugs | 466 | 448 | 11,737 | 12,520 | 2,498 | 2,778 |
| Schooners | 730 | 577 | 183,792 | 158,620 | 5,399 | 4,726 |
| Barges | 350 | 325 | 125,975 | 144,038 | 3,151 | 4,968 |
| *B—Material:* | | | | | | |
| Steel | 6 | 68 | 6 459 | 99,457 | 694 | 11,964 |
| Iron | 35 | 39 | 22,714 | 24,673 | 2,675 | 2,638 |
| Composite | 2 | 13 | 63 | 13,554 | 39 | 1,465 |
| Wood | 1,954 | 1,935 | 605,416 | 688,676 | 27,189 | 42,061 |
| *C—Sail or steam:* | | | | | | |
| Steam vessels | 937 | 1,153 | 324.885 | 523,702 | 22,047 | 48,434 |
| Sailing vessels | 1,000 | 902 | 309,767 | 302,658 | 8,550 | 9,694 |

TABLE II.—PERCENTAGES OF INCREASE SHOWN IN TABLE I.

| CLASSIFICATION OF VESSELS. | Percentage of increase, 1886-1890, in | |
|---|---|---|
| | No. vessels. | Tonnage |
| Total | 2.9 | 30.2 |
| *A—Structure:* | | |
| Side wheel steamers | (—2.3) | 20.0 |
| Propellers under 1,000 tons | 28.7 | (—13.2) |
| " " 1,000 to 1,500 tons | 69.4 | 74.8 |
| " over 1,500 tons | 424. | 440. |
| Tugs | (—3.9) | 6.7 |
| Schooners | (—21.0) | (—13.7) |
| Barges | (—1.5) | 14.3 |
| *B—Material:* | | |
| Steel | 1,033. | 1,441. |
| Iron | 11.4 | 8.8 |
| Composite | 550. | 2,141. |
| Wood | (—1.0) | 13.7 |
| *C—Sail or steam:* | | |
| Steam vessels | 23.0 | 61.0 |
| Sailing vessels | (—15 0) | —2 3 |

It will be seen that the great increase is in large propellers built of steel. Small propellers have actually decreased in tonnage, though they have increased in number, probably because they are chiefly used for towing purposes. The values per ton shown in Table III. present some anomalies which we cannot attempt to explain, and they are hence to be taken with some grains of allowance.

TABLE III.—VALUE PER TON OF SHIPPING ON THE GREAT LAKES.

| CLASSIFICATION OF VESSELS. | 1886. | 1890. |
|---|---|---|
| Side-wheel steamers | $105.00 | $130.20 |
| Propellers under 1,000 tons | 53.40 | 90.20 |
| " 1,000 to 1,500 tons | 68.30 | 77.80 |
| " over 1,500 tons | 75.90 | 94.30 |
| Tugs | 21.30 | 22.25 |
| Schooners | 29.40 | 29.80 |
| Barges | 25.60 | 34.50 |
| *Material:* | | |
| Steel | 107.30 | 120.10 |
| Iron | 117.80 | 107.00 |
| Composite | 61.90 | 108.80 |
| Wood | 45.00 | 61.20 |
| Steam vessels | 67.90 | 92.30 |
| Sailing vessels | 27.60 | 32.00 |
| Average | 48.30 | 73.00 |

The Census Bulletin justly adds that it is difficult to add anything to the impression which a study of these figures must produce. New factors of great importance are being introduced into the problem of transcontinental transportation.

## The Floods in North China.

The floods in North China are made the subject of a report by Mr. WILLIAM BOWMAN, United States Consul at Tien-Tsin. He says that the drainage of the great Chinese plain, north of the Yellow River, centers practically at and above Tien-Tsin, and the accumulation of water is carried by the Pei-Ho River into the Gulf of Pechili.

In ordinary seasons this stream is filled to the brim by the July rains, and is only confined by levees. The rains causing the late disastrous flood began on July 7, and 5 54 ins. fell that day. From the 16th to the 21st, inclusive, 22 ins. of rain fell, with 4.2, 6.8, 3.7, 1.6 and 5.7 ins. for each day's record. Reports from the north and northwest of Tien-Tsin indicate selaivl thier rains in the regions draining into this river. On July 22 the levees gave way above the foreign settlement on the east and west side, and the plain was covered with water as far as the eye could reach. On July 22 the levees on the Grand Canal broke at a point about 7 miles above Tien-Tsin, and thus saved the city from destruction, but flooded a vast area to the south and west.

The situation of Tien-Tsin is peculiar. The Pei-Ho passes through it, and just at that point center the Lao-Ho, Yung-Ting-Ho, Ta Ching Ho, Hsia Hsi Ho and the Grand Canal. In other words, six great waterways unite at this city and pass on to the sea by one river, the Pei Ho. These rivers drain a section of country which is covered by a radius of 150 miles drawn from Tien-Tsin as a center.

# CONSTRUCTION NEWS.

## RAILWAYS.

### EAST OF CHICAGO.—Existing Roads.

***Lehigh Valley***—Chief Engineer Paul S. King has awarded the contracts for a portion of the work on the extension from Van Ettenville to Buffalo, N. Y., being built under the names of the Buffalo & Geneva and the Geneva & Van Ettenville railways. The contractors are as follows: Jas. H. Sullivan, New York City, sections 1 to 7, and Richard Dooley, New York City, sections 7 to 13, from Geneva, N. Y., west. On the division from Geneva south the contractors are: McDonnell & Sayre, South Bethlehem, Pa., sections 44 to 51, and John Shields, Flemington, N. J., sections 51 to 57. Work will commence at once.

***Wabash.***—The managers of this company, it is stated, have decided to build a branch from Attica, Ind., via Covington and Montezuma, to Brazil, Ind., during the present season. The object of the road is to gain entrance to the Brazil coal fields.

***New York Central & Hudson River.***—Surveys are again reported in progress for an extension of the New York & Harlem R. R. to Danbury, Conn.

***Lake Shore & Michigan Southern.***—Drake & Stratton, of 71 Broadway, New York City, have the contract for building the Silver Creek & Dunkirk R. R., from Silver Creek to Dunkirk, N. Y., 9 miles.

***Reynoldsville & Falls Creek.***—This road will be extended to Punxsutawney, Pa., during the coming summer.

***Gettysburg & Chambersburg.***—S. D. Culbertson, of Chambersburg, Pa., Chief Engineer, writes as follows:

About 75 men are now at work on this Pennsylvania railway under the direction of J. F. Stauffer, Lancaster, Pa., the contractor. Nearly 5 miles of the grading have been completed and tracklaying will begin early in the spring. The road is projected to run from Conocobeague Island via Fayetteville to Graefenburg, Pa., with a branch from the last place to the Wolf Hill mines, a total distance of 10 miles. The work on the main division will be light, with easy grades and curves, but on the branch it will be more difficult; maximum grade 2% and maximum curve 12°. The right of way has all been secured and the surveys made. The road is being built to develop the mines along the route and will probably do a freight business only.

### Projects and Surveys.

***Bangor & Aroostook.***—Albert A. Burleigh, of Houlton, Me., writes as follows:

This road is projected to run from Brownsville, Me., via Patten, Houlton, Presque Isle, and Caribou, to Van Buren, Me., a distance of 175 miles. The route is through a timber and agricultural country, affording light work; maximum grade, 65 ft. per mile, and maximum curve, 5°. There will be 5 large bridges. Surveys will begin in May, and it is expected to have a portion of the line completed this season. A large amount of the stock has been taken.

***Plymouth & Bournedale.***—A new survey is to be made for this projected railway between Plymouth and Bournedale, Mass., 22 miles.

***Ohio.***—A project is on foot to build a line of railway connecting the harbors of Painesville and Richmond, O., with the New York, Pennsylvania & Ohio R. R., at Phalanx, O. Its length will be about 50 miles.

***Shoustown & Clinton.***—Surveys are being made along the partly graded roadbed of this old Pennsylvania railway. The road will be about 7 miles long, and run from Shoustown to Clinton, Allegheny Co., Pa.

SOUTHERN.—Existing Roads.

***West Virginia Central & Pittsburg.***—The annual report of this company states that work has been commenced on the extension from Elkins, W. Va., toward Beverly and Roaring Creek and will, it is expected, be completed this year. Surveys are being made with a view of securing connections with Pittsburg, Pa., on the north and with the Chesapeake & Ohio R. R. on the south. The company is also doing a large amount of work on the improvement of its roadbed and track.

***Augusta & West Florida.***—It is announced that the necessary arrangements have been completed for the construction of this road from Augusta, Ga., to Thomasville, Ga., and that work will soon begin. The road will build only from Augusta to Gainsville at present, using the tracks of the Gainsville & Wadley and the Georgia Southern & Florida railways into Thomasville

***Charleston, Sumter & Northern.***—Work on the extension to Bennettsville, S. C., is making rapid progress. The grading is nearly completed from Sumter to that place.

***Paducah, Tennessee & Alabama.***—Bids are being asked for the construction of the section from Paris, Tenn., to the Nashville, Chattanooga & St. Louis R. R., 22 miles.

***Fort Payne & Eastern.***—At a recent meeting of the stockholders it was decided to begin at once the surveys for the extension to Rome, Ga., and the Atlantic coast. The road is now completed from Fort Payne, Ala., to the Payne coal mines, and work will begin at once on a further extension to the Chattanooga Southern R. R., 8 miles. The officers are: President, L. A. Dobbs; Vice-President, J. W. Spaulding, and General Manager, R. T. Armstrong.

***South Florida.***—Surveys are now being made for the proposed extension from Pemberton, Fla., to a connection with the Savannah, Florida & Western R. R., and it is stated that construction will begin this spring. The line will be about 80 miles long.

***Norfolk & Portsmouth Belt.***—It is announced that work has been commenced on the proposed belt line around the cities of Norfolk and Portsmouth, Va., and that the road will be completed this season.

***Orange & Keysville.***—There is a prospect of work commencing on this Virginia railway between Orange C. H., and Farmville, Va. About 7 miles of the line are already partly graded.

***Ohio River.***—About 8½ miles of track have been laid on the Ravenswood, Spencer & Glenville R. R., from Ravenswood, W. Va., toward Spencer, W. Va. The total length of the line will be 36 miles.

Projects and Surveys.

***Mississippi Central Valley.***—Chas. Scott, of Rosedale, Miss., President, writes as follows:

The surveys have been completed for this line from Rosedale to Bogue Phalia, a distance of 6½ miles, and the right of way is nearly all secured. Contracts for construction will be let during June. The work will be generally light. The road will be operated in connection with a line of boats on the Bogue Phalia. The town of Rosedale has voted a subsidy of $12,500 in 6% bonds and a considerable additional aid has been secured. John T. Kuhn is Vice-President and R. B. Eggleston is Chief Engineer.

***East Tennessee Land Co.***—Hood Tucker, of Harriman, Tenn., Chief Engineer, writes as follows:

The surveys are completed and contracts will be let in April for the construction of this railway from Harriman, Tenn., to mountains, 14 miles. The work will be light; maximum grade 1.25%, and maximum curve 10°. The road is being built to develop coal mines. The officers are: Thos. L. James, New York City, President, and W. H. Russell, Harriman, Tenn., General Manager.

***North Carolina.***—Bills incorporating the following railway companies have been introduced into the North Carolina State Legislature: Greensboro, Roxboro & Eastern; Carolina, Greensville & Northern; Edgecombe & Greenville; Deep River & McLendon Valley; Blue Ridge; Piedmont Springs R. R. & Imp. Co.; North Carolina, Cleveland, Chattanooga & Dayton; Norwood & Rockingham; Thomasville & Silver Valley; Asheville & Bristol; West Asheville & Sulphur Springs; Hendersonville & Brevard; Hot Springs, Carolina, Jonesville & Northern; Southeastern North Carolina; North Carolina Seaboard & Western; South Carolina, Seaboard & Northern; Cape Fear & Northern; Cobarrus & Union; Georgetown & Charlotte; Atlantic & Western; Carolina & Virginia; Wilmington & Southern; Marion Belt; Durham Belt; Asheville & Baltimore; Danville & Eastern; Asheville & Weaversville; Concord Southern; Norfolk, Wilmington & Charleston; Brunswick, Western & Wilmington; Danville, Granite City & Western Short Cut, and Carolina & Virginia.

***Cynthiana Western.***—Surveys are now in progress for this road from Cynthiana to Georgetown, Ky.

***Webster County.***—A company has been formed to build a railway from the mouth of Williams River to Webster C. H., Webster Co., W. Va., upon the completion of the West Virginia & Pittsburg R. R. to the latter point. It is expected to begin work this spring, and to complete the road during the summer. It will be narrow-gage.

***Alabama, Florida & Mississippi.***—This railway company has been chartered in Alabama.

***Mississippi.***—G. M. Merrill & Son will build a short line of railway near Bayou Goula, Miss.

***Charlottesville Belt.***—It is stated that the Charlottesville Land & Improvement Co. will soon begin work upon a belt railway at Charlottesburg, Va.

NORTHWEST.—Existing Roads.

***Port Arthur, Duluth & Western.***—About 2,000 men are now at work on the section between Gun Flint Lake and Whitefish Lake. Tracklaying will begin soon.

***Chicago, St. Paul, Minneapolis & Omaha.***—This company has secured control of the Sault Ste. Marie & Southwestern R. R. in Wisconsin, and will, it is stated, build an extension during the present season.—It is reported that the construction of a branch from Ellsworth to Mondovi, Wis., has been abandoned.

***Chicago, Milwaukee & St. Paul.***—Surveys are in progress for an extension from Lynn, Wis., north to Thorpe, Wis.

Projects and Surveys

***Chicago, Indiana & Eastern.***—Chartered in Illinois to build a railway from a point on the Indiana State line in Cook Co. to Chicago, Ill. The capital stock is $5,000,000 and the principal office is in Chicago. The incorporators who are named as the first Board of Directors are as follows: Herbert Thiers, N. P. R. Hatch, Thomas N. White, head, F. B. Bray and Charles Wheelwright, all of Chicago.

***Springfield, Sedalia, Marshall & Northern.***—The surveys have now been completed from Springfield, Mo., to Buffalo, Mo., and work securing the right of way will begin at once. It is expected that the surveys will be completed at once to Sedalia, Mo., by May 1, and to Marshall by June. G. A. C. Wooley, Springfield, Mo., Secretary.

***Wisconsin Bee Line & Superior.***—At a recent meeting of the stockholders the following directors were elected: Anthony Dorqua, C. D. Smith and M. P. Smith, of Fond du Lac; O. N. Carter, Chicago, and J. T. Murphy, Superior. C. D. Smith is the President and M. P. Smith Treasurer of the road. It is stated that work on construction will begin as soon as weather permits. The road is projected to run from Milwaukee to Superior, Wis., 360 miles. C. W. Newton, of Fond du Lac, Wis., is Chief Engineer.

***Mankato & Farmington.***—Efforts are being made by the people along the route to secure the construction of a railway from Mankato to Farmington, Minn.

SOUTHWEST.—Existing Roads.

***Choctaw Coal & Railway Co.***—The section of this road between Fort Reno and Oklahoma City, Ind. Ter., is reported completed.

***Corpus Christi & South American.***—The citizens of Refugio, Tex., are endeavoring to secure an extension of this road to that place.

***San Antonio & Aransas Pass.***—The receivers of this road have, it is stated, made arrangements for completing the line from Yoakum to Waco, Tex. The road is already completed from Yoakum north to Lockhart and from Waco south to Lott. The section to be built is about 53 miles long.

***Grand Central Depot Co.***—This company, organized in the interest of the Winner Investment Co., has filed a mortgage of $1,000,000 with the Union Trust Co., of New York City. The money will be used in constructing a union depot at Locust and Third Streets, Kansas City, Mo., near the end of the recently completed Winner bridge. Work, it is stated, will begin an once.

***Norfolk & Western.***—This company will expend about $600 000 in making improvements in its terminal facilities at Newport, Va. The work will comprise the construction of a union passenger station, a train shed 350 ft. long, a freight depot, and the filling of Mahone's Lake.

***Kansas City, Memphis & Birmingham.***—Surveys are in progress for a branch from Townley, Ala., to Coal Valley.

***Kansas City Circular.***—This company has been organized to build a belt line transfer railway at Kansas City, Mo. Among the projectors are: Michael McAlpin, and A. P. Fonda.

***California & Nevada.***—A press dispatch says:

The California & Nevada, a narrow-gage railway in Alameda Co., Cal., has been sold to Eastern capitalists, who will change the road to standard gage, and extend it across Nevada to Pioche, and thence to Grand Junction, Colo., on the Colorado Midland R. R. The name of the road will be changed to the California, Nevada & Santa Fe, and it is the intention to build the shortest and most direct line to Kansas City and Chicago. The line from Great Bend to Colorado Springs is to be finished, still further shortening the distance to the East.

***Cartersville & Gainesville.***—A preliminary examination of the route of the proposed railway from Cartersville, Ga., via Canton, Tate and Dawsonville, to Gainesville, Ga., has been made by Parker N. Black, of Atlanta, Ga. The engineer in his report says:

The length of the line to be constructed from the East & West R. R. at Cartersville to Dawsonville will be 46 miles. Three miles only to grade east of Dawsonville. The remainder of the distance to Gainesville is graded and the track laid from the Chestatee River to Gainesville, including a bridge across the Chattahoochee River. The total length of the line will be about 73 miles. There will be four large bridges, one across Etowah River northwest of Emerson, and one west of Canton, one at the Amicoloa River west of Dawsonville and at the Chestatee River. Four small bridges will have to be built at Altoona Creek, east of Emerson, and at Little River near Cherokee Mills. Long Swamp Creek near Tate, and at Yellow Creek west of Dawsonville. One tunnel may be required at the crossing of the Marietta and North Georgia Railroad. Very little trestling will be required, but few large cuts and fills.

Projects and Surveys.

***Fort Gibson, Tahlequah & Northwestern.***—Congress has granted this railway right of way through Indian Territory. The road is projected to run from Fort Gibson, Ind. Ter., via Tahlequah, Silvan Springs and Bentonville to Rogers, Kan. It is expected that construction will begin soon.

***Arkansas.***—A movement is on foot to secure a line of railway from Kansas City, Mo., to Texarkana, Ark., and Shreveport and Natchitoches, La. It is proposed to use the Texarkana & Fort Smith R. R. from Texarkana, Tex., north to a connection with the St. Louis & San Francisco R. R., and the latter road into Kansas City. From Texarkana south the Gate City Ry. will be purchased and extended south to Shreveport and Natchitoches.

ROCKY MT. AND PACIFIC.—Existing Roads.

***Port Townsend Southern.***—The contractors, Hale & Smith, have commenced work on the 7-mile extension from Hooker's Lake to Quilcene, and will have it completed by June 15. Ballasting is in progress on the 20-mile section from Port Townsend to Hooker's Lake, completed last year.

***Northern Pacific.***—This company is surveying a line into New Whatcom, Wash., around the Sound and the west shore of Lake Whatcom.

Projects and Surveys.

***Salt Lake, Hailey & Puget Sound.***—According to the *Salt Lake Tribune* this company has secured the money necessary to build 200 miles of its proposed line from Salt Lake City, Utah, northwest, through Idaho and Washington to the coast.

***Mexican Pacific.***—Chartered in New Mexico Territory to build a railway from Deming, N. Mex., south into Mexico. John W. Young, Salt Lake City, Utah, is at the head of the enterprise.

***California.***—A press dispatch states that surveys are in progress for a railway from Fresno, Cal., to the timber district, which, with branches, will be about 100 miles long.

FOREIGN.

***Paraguay.***—The surveys have been completed and the contracts let for the construction of a railway from the northern provinces to the boundary of Bolivia. It is stated that work will begin at once.

***Central America.***—A concession has been granted for the extension of the road now in operation between Port Limon and San Jose to the shores of Lake Nicaragua.

## CITY TRANSIT.

**Electric Railways.**—New lines or extensions of existing systems are reported as probable in the following places: Bryan, Tex.; Dallas, Tex., address the Consolidated Street Railway Co.; Philadelphia, Pa., address the Traction Co.; Rockford, Ill.; Woburn, Mass., address the East Middlesex Street R. R.; Little Rock, Ark., address the Capitol Street Ry.; Charlottesville, Va., address the Charlottesville & University Street Ry.; Dawson, Pa., address Col. A. J. Hill; Gloucester, Mass., address the Gloucester Street Ry.; Buena Vista, Colo., address the Buena Vista Electric Light Co.; North Adams, Mass.; Bristol, Tenn., address the Bristol Street Car Co.; St. Paul, Minn., address the Wage-earners' Co-operative Home Association; Milwaukee, Wis., address Col. Chas. Pfister; Brownwood, Tex., address C. Vincent. Harlem, Ill.; Ann Arbor, Mich., address the Ann Arbor Electric Street Ry.; Peoria, Ill.; Cumberland, Md., address the Cumberland Street Railway Co.; Norristown, Pa., address the Norristown Traction Co.; Bryan, Tex.; New Albany, Ind.; Waterloo, Ia.; Fitchburg, Mass., address M. D. Haws; Stockton Springs, Me., address N. F. Houston.

***Worcester, Mass.***—The directors of the Worcester, Spencer & Leicester Ry. have applied for a charter and will be ready soon to let contracts.

***New York, N. Y.***—Reed & McKibbin, 32 Liberty St., are engaged on plans for 17 miles of street railway.

***Lockport, N. Y.***—It is reported that nearly all the right of way for the new road to Niagara Falls has been obtained. If the line is built it will be one of the longest electric railways yet constructed, since the route as proposed is over 80 miles long.

***Harrisburg, Pa.***—The City Passenger Ry., operating 5 miles of horse railway, has been leased to the East Harrisburg Passenger Ry., which will introduce electricity.

***Asheville, N. C.***—L. Williams and F. Reynolds have applied for a charter to build an electric railway from this place via Chimney Rock to Rutherfortiton.

***Columbia, S. C.***—The Columbus Electric Street & Suburban Ry. will, it is reported, purchase the lines of the Columbia Street Ry. and operate them by electricity.

***Chattahoochee, Ga.***—The Chattahoochee Land Co. will, it is said, build a 4-mile road to Atlanta.

*Anderson, Ind.*—It is reported that a Buffalo syndicate has bought the street railway in this city and will introduce electricity.

*Muskegon, Mich.*—J. A. Hart, of Manistee, will possibly construct an electric railway from this town to Oak Hill.

*Sioux City, Ia.*—The power-house and part of the rolling stock of the City Railway Co. was burned on March 4. The loss is estimated at $75,000.

*Spokane Falls, Wash.*—It is reported that the Spokane & University Heights Street Railway Co., recently incorporated, will construct and operate a 5-mile electric railway.

**Horse Railways.**—New lines or extensions of existing systems are reported as probable in the following places: Talladega, Ala., address the Alabama Iron, Land & Furnace Co.; Martinsburg, W. Va.; Baltimore, Md., address the North Baltimore Passenger Railway Co.; Flushing, N. Y., address the Flushing & College Point Street Railway Co.; Salem, Va., address A. M. Bowman, Plainview, Tex.

*Buffalo, N. Y.*—It is reported that surveys are being made for a street railway to Seneca. The estimated cost of the line is $80,000.

*Centralia, Ill.*—Surveyors are now laying out the lines of the street railway, and work will begin, it is reported, as soon as the weather permits.

**Dummy Railways.** *Pensacola, Fla.*—The Pensacola Street Car Co. has been reorganized with T. C. Watson as Secretary. It is reported that a number of new lines will be constructed and operated by steam motors.

*Memphis, Tenn.*—It is reported that the East End Railway Co. will extend its track and replace its 35-lb. rail by rails weighing 50 lbs. per yd.

**New Companies.**—Spokane & University Heights Street Railway Co., Spokane Falls, Wash.; A. V. Garrat, President, and L. B. Cornell, Secretary. Harding Electric Railway Co., Atlantic, Ia.; capital stock, $1,000,000, Lincoln, Ill., Electric Street Railway Co.; capital stock, $35,000,000; incorporators, E. D. Blinn, A. Quisenberry, J. F. Mundy. West End Railway Co., Charleston, S. C.; capital stock, $250,000; G. B. Edwards, President, and K. S. Tupper, Secretary. Indianapolis & Greenwood Railway Co., Indianapolis, Ind.; capital stock, $150,000; incorporators, J. T. Polk, G. Johnson, M. Howland and others. Citizens' Rapid Transit Co., Chicago, Ill.; capital stock, $6,000,000; incorporators, C. Waller, P. George, F. Francis, L. C. Ehle. Centralia & Central City Street Railway Co., Centralia, Ill.; capital stock, $10,000; incorporators, A. Dunker, G. E. Eis, G. P. Duncan and others.

## HIGHWAYS.

*Maryland.*—The York Road turnpike near Baltimore is reported to be in bad condition, and the York Road Ry. Co. will be called upon to improve it. At a meeting of farmers at Tenby's, Carroll Co., a committee was appointed to request the county commissioners to assist in macadamizing Washington road for 4 or 5 miles where the traffic is heaviest.

*New York.*—A macadamized road between New York, N. Y., and Boston, Mass., is projected, and a committee recently visited Bridgeport, Conn., and went over the ground in that district. The road will be the main highway running from New York as far as Fairfield, where a new road will be cut through to Bridgeport, continuing along the old "King's Highway" or Boston road, as far as Newport, thence taking a shore road to Boston. It is stated that at an early date delegates from each city through which the road will run will meet in New York. Committees from the three states will then be appointed, and a petition sent to the Legislature of each state, asking for appropriations to construct the road.

*Ohio.*—The Bellevue & Dayton Improvement Co. has been incorporated by James L. Anspaugh, Charles Barnes, J. R. Harms, T. F. Beyland, Herbert Winter, Adam Smyrl, George P. Quiggins and C. W. Nagel, to encourage, promote, and by subscriptions and donations, establish a connecting roadway, 40 ft. wide, from Newport to Bellevue, above high water. The capital stock is $20,000.

*Pennsylvania.*—A committee appointed at Doylestown to consider the road laws now before the Legislature have passed resolutions to the effect that they are opposed to the bills, as they create too many offices, and the money received by each district would be so small as to be practically valueless; they are in favor of macadamized roads only so far as corporate companies can be formed who are willing to construct them with the aid of state appropriations, and thereafter take care of them. They consider that the most practical and feasible method would be for the state to appropriate not less than $500 per mile to each and every corporate company that would agree to construct a macadamized road or turnpike and thereafter keep it in repair, the said company to refund all money accruing from tolls amounting to over 5% of the capital stock, after paying all necessary expenses for maintaining the road to the township or townships through which it passes for road improvement. The Berks Co. Agricultural Society has endorsed the road commission bill.

*Massachusetts.*—Mr. Carpenter, of Foxboro, has suggested that the state should build state roads between the important cities, and there will be a hearing March 17 before the Committee on Roads and Bridges. The plan is to have the state appropriate a large sum each year, meeting the same by bonds, to be expended under state engineers, on an improved system of highways. First the center of the road would be excavated, and a drain laid at the bottom; then it would be filled in, sloping toward the center, as to insure perfect drainage, and a consequently perfect roadbed at all seasons. Not only does this plan furnish superior roadbeds for the most used highways, but it incites the towns to improve their adjoining roads. By having the state advance the funds, instead of the towns, the cost of the improvement could be saved in a comparatively short term of years.

## BRIDGES, TUNNELS AND CANALS.

**Bridges.**—*Canada.*—The Royal Bridge & Iron Co., of Montreal, is applying to the Dominion Parliament for a charter for the manufacture and construction of iron, steel and other bridges. The amount of the capital stock of the company will be $30,000.

*Waterford, Vt.*—An iron bridge will be built over the Connecticut River at this place.

*District of Columbia.*—Congress has appropriated $60,000 for the construction of an iron bridge across the Eastern Branch at Benning's road.

*Allegheny, Pa.*—Plans for a bridge at Herr's Island have just been completed by City Engineer Ehlers. The plans call for a bridge to be built over the Pittsburg & Western and West Penn R. R. tracks, and to extend from Ohio street to the island. It is not yet known whether the railroad companies will pay part of the cost of construction or not. The exact cost of the structure is not yet known, but it will cost approximately $90,000. The heaviest cost will be in the filling in of the approaches.

*Knoxville, Tenn.*—The Cherokee Land Co. will let contracts for the iron bridge across the Tennessee River in about two months. R. A. McConnell, Secretary.

*Little Rock, Ark.*—Bids are called for by Hon. Jacob Erb, County Judge of Pulaski County, Ark., for a free bridge to be constructed across the Arkansas River at this point.

*Palestine, Tex.*—The International & Great Northern Ry. will build a bridge across the Neches River, 15 miles north of this place.

*Longwood, Tex.*—A bridge will be built over the Sabine River by the International & Great Northern Ry.

*Oregon.*—The Oregon Legislature has passed bills relating to bridge-work in that state, as follows:

*Bridge at Sellwood.*—The Sellwood Bridge Co. is authorized to build a bridge across the Willamette at that city, with a draw not less than 110 ft. in the clear, and said bridge must be open for traffic Jan. 1, 1893. *Columbia Co.*—Columbia Co. is authorized to construct and maintain bridges across the Clatskanie and Beaver Rivers, on the line of the county road between Clatskanie and Mayger's Landing, on the Columbia. These bridges shall be so built as not to interfere with navigation on said rivers. *Albany & Astoria R. R.*—This company is authorized to build a drawbridge across the Willamette River, between Benton and Linn counties. Work must be begun within two years, and $10,000 be expended within the year following. *Free Bridge at Albany.*—The city of Albany and the counties of Linn and Benton, or either of them, are authorized to build a bridge across the Willamette, which shall be free to all persons and vehicles. The Coos Bay, Roseburg & Eastern Ry. and Navigation Co. is authorized to build a bridge across Coal Bank slough in Coos Co. *Across Young's Bay.*—The Astoria, Seashore & Eastern R. R. Co. is authorized to construct bridges across Young's Bay and Lewis and Clarke River in Clatsop Co.

*San Francisco, Cal.*—The following bids were opened by Colonel Mendell, U. S. Engineer Office, Feb. 28.

For 315 ft. draw span and two 34-ft. approaches, two 6-ft. sidewalks, capacity 80 lbs. per sq. ft., and 25 ft. clear roadway, capacity 60 lbs. per sq. ft. Floor system to carry in addition a 15-ton road roller. Bids to include granite copings for all piers and abutments, concrete for approach abutments, and to state price for hand and for steam power.

| Company. | Hand Power. | Steam Power. |
|---|---|---|
| King Iron Bridge Co., Cleveland, Ohio... | $31,260 | 33,060 |
| Pacific Rolling Mill Co., San Francisco.. | 32,640 | 34,290 |
| San Francisco Bridge Co..... | 32,867 | 33,867 |
| California Bridge Co ..... | 36,900 | |
| Wrought Iron Bridge Co., Canton, Ohio. | 35,860 | 38,360 |
| Pacific Bridge Co., San Francisco..... | 42,300 | 46,290 |
| Bay City Iron Works, San Francisco.... | 49,778 | 54,278 |
| Berlin Iron Bridge Co., East Berlin, Ct... | 53,784 | 59,003 |

## WATER-WORKS.

### NEW ENGLAND.

*Belfast, Me.*—The Legislature has authorized the Belfast Water Co. to extend its mains to supply Northport.

*Rutland, Vt.*—Chappell & Burke are preparing plans for a new 5,000,000-gall. reservoir and a 12-in. supply main; estimated cost, $50,000 to $75,000. J. M. Davis is Superintendent.

*Manchester, Mass.*—S. Knight informs us that it is expected that an act will soon be given, permitting the construction of works. P. M. Blake has made a report on the proposed works.

*Somerville, Mass.*—The Council has ordered the issuance of $60,000 of water loan extension bonds.

*Providence, R. I.*—An effort is being made to secure an amendment to a recent act incorporating the Pawtuxet Valley Machine Co., changing the name to the American Water-Works Co., authorizing a capital stock of $15,000,000, and the owning, constructing and operating of water-works, with power to acquire, manage and convey real estate, and to own, deal in, and guarantee the stock and obligations of other corporations. The incorporators named are Enos Lapham, Centreville; Richard Thornley, C. C. Gray, E. H. Wilson. It is stated that the company proposes to supply villages in the Pawtuxet Valley; also that it aims to secure control of the water rights of the western part of the State. The bill has passed the Senate, but it is thought that it will be killed in the House.

### MIDDLE.

*Holland, N. Y.*—C. A. Button, Secretary, informs us that W. B. Jackson is President and A. Cutler is Treasurer of the Holland Water-Works Co. Nothing definite has yet been done toward construction.

*Lockport, N. Y.*—F. N. Trevor, Chairman, informs us that a committee is investigating the question of obtaining an additional supply. Extensive improvements will depend upon the report.

*Mechanicsville, N. Y.*—Regarding the report that works are to be built here, N. W. Kelso, Town Clerk, informs us that nothing definite has yet been done.

*Rochester, N. Y.*—A company, of which T. B. Moore is secretary, has offered to furnish the city with a daily supply of 3,000,000 galls. at 3 cents per 1,000 galls., from a small lake near Bushnell's Basin, about 11 miles southeast of Rochester, or it will sell the lake to the city. The company estimates that it can deliver water to Mt. Hope Reservoir for 3 cents per 1,000 galls.

*Rockville Centre, N. Y.*—This Long Island village is discussing works. There is talk, merely, of organizing a local company with a capital stock of $25,000. W. M. Hawkins, J. T. Davis and others have been appointed as an investigating committee.

*Homestead, Pa.*—M. P. Schooley, Borough Clerk, has sent the following:

Jacob Schinneller, Pittsburg, is preparing plans for works, and separate bids will soon be wanted for pumping engines, mains and reservoirs. Direct pressure will be used, the surplus going to a reservoir. It is expected that the works will be completed by fall.

*Montrose, Pa.*—It is reported that F. S. Pecke, Watertown, N. Y., has received a franchise for works, water to be pumped from a lake to a steel tower. W. L. Cox informs us that M. J. Drummond, 192 Broadway, is President of the company; that water will be pumped to a stand-pipe from a lake 1¼ miles distant; that the works will probably cost $40,000, and that construction will be started April 15.

*New Castle, Pa.*—The company has offered to sell its works to the city for $200,000, or to build a new reservoir on Walnut Hill, within the city, provided a new schedule of rates running 10 years will be agreed to.

*Steelton, Pa.*—James Gamble, 68 Wall St., New York, informs us that he and associates have bought the franchise for works here, and will at once begin operations. Water will be pumped to a reservoir. Population, 9,200.

### SOUTHERN.

*Radford, Va.*—Arthur Roberts, Town Clerk, informs us that the town will put in works during the coming summer, providing it can sell $13,000 of bonds. Correspondence regarding the latter is desired.

*Walhalla, S. C.*—The Norman-Carroll Co. has been incorporated to put in water-works and electric lights and to develop mines; capital, $10,000.

*Savannah, Ga.*—T. T. Johnson will make plans for a new pumping station and machinery. E. F. Joyce has been awarded the contract for a 12-in. artesian well. The appropriation available for new works is $60,000.

*Tallapoosa, Ga.*—The Tallapoosa Water Co. put works in operation Feb. 19. Woltman, Keith & Co., 11 Wall St., New York, were Contractors. The supply is pumped to a stand-pipe and direct. There are 4½ miles of mains.

*Fernandina, Fla.*—The extension of the works into the northern part of the town is under consideration.

*East Lake, Ala.*—The East Lake Water & Electric Co. proposes to build works.

*Greenville, Tenn.*—Authority to issue bonds for works has been asked.

*Stanford and Rowland, Ky.*—The Stanford Water-Works Co. has been incorporated by J. F. Peyton, of Knoxville, J. S. Hughes, C. F. Sturtevant, and others, to construct water-works, gas or electric light works, and to manufacture ice; capital stock, $75,000.

### NORTH CENTRAL.

*Fernbank, O.*—The Ohio Water & Light Co. has been incorporated; capital, $5,000.

*Nelsonville, O.*—A bill has passed the House authorizing the issuance of $60,000 water bonds.

*Sandusky, O.*—Bids will be received by the city until March 21 for $100,000 5% refunding water bonds. The bonds will fall due in lots of $10,000 until all are redeemed, the first lot falling due 5 years from date of issue, April 15 next.

*Tiffin, O.*—Improvements to the works are to be made.

*Toledo, O.*—J. D. Cook, Consulting Engineer, and D. Segur, Secretary of Water-Works Trustees, inform us that bids will be received until April 2 for a 15,000,000-gall. pumping engine, to lift water from the Maumee River to an altitude of 200 ft. for ordinary, and 260 ft. to a stand-pipe, for fire service. The duty must be not less than 110,000,000 ft. lbs. when under 200 ft. head. Specifications can be had on application after March 6.

*Zanesville, O.*—Farson, Leach & Co., Chicago, were the highest bidders for $50,000 water bonds, recently offered. Their bid was $1.01¼.

*Franklin, Ind.*—The Franklin Water, Light & Power Co. informs us that they wish quotations on cast-iron pipe. Their system will include 7 miles of 10 to 4-in. mains.

*Menominee, Mich.*—A. H. Howland, Boston, Mass. Treasurer of the Menominee Water Co., informs us that the company contemplates quite an increase to the works, but nothing has yet been authorized.

*West Bay City, Mich.*—The Council has voted $25,000 of bonds for improving and extending the works. A popular vote will be taken on the question at the spring election.

*Chicago, Ill.*—The specifications for the two 12,000,000 gall. pumping engines, for which bids are asked in our advertising columns, provide that all bids must be accompanied by drawings; that the engines must work either conjointly or independently, and that they must develop a duty of not less than 100,000,000 ft. lbs. for each 100 lbs. of coal consumed. Plans and estimates are being prepared for water supply and sewerage for the Columbian Exposition by W. S. MacHarg, of Chicago.

*Harlem, Ill.*—E. A. Cummings & Co., Chicago, have offered to donate to the village a lot 80 × 160 ft., as a site for a water-works and electric light station.

*Marshfield, Wis.*—Moffett, Hodgkins & Clarke, Syracuse, N. Y., have proposed to put in 5 miles of mains and 75 hydrants, the latter at an annual rental of $4,000. The supply will be from the Yellow River or artesian wells.

### NORTHWESTERN.

*Tekamah, Neb.*—E. B. Atkinson, City Clerk, informs us that $13,000 of water bonds have been voted, the vote standing 159 to 36.

*Evanston, Wyo.*—It is reported that a domestic supply will be furnished the city from the proposed ditch of the Bear River and Yellow Creek Irrigation & Land Co., mentioned more fully below, under Irrigation.

### SOUTHWESTERN.

*Columbia, Mo.*—Bonds to the amount of $45,000 were recently voted for water-works and electric lights. An unsuccessful attempt has just been made to obtain an injunction preventing construction.

*Tyler, Tex.*—B. W. Rowland, Secretary, informs us that the company intends to build a dam and storage reservoir. A supply main 3½ miles long is being laid, and an additional stand-pipe will be built. All the important contracts have been let.

### PACIFIC.

*Dayton, Wash.*—J. H. Day, Chairman Fire and Water Committee, informs us that the people have voted, 8 to 1, to bond the town for $75,000 for water-works.

*Forest Grove, Ore.*—The Forest Grove & Gales Creek Flume Co. has been incorporated; capital, $100,000.

*Independence, Ore.*—A mile of mains and 10 new hydrants are under consideration.

*Portland, Ore.*—Superintendent T. W. Smith estimates that 1,470 tons of pipe will be needed for the city distribution in 1891.

*Santa Monica, Cal.*—The trustees have appointed a committee to investigate the question of a water supply. Rustic Cañon has been mentioned as a source. T. A. Lewis is one of the committee.

*Salt Lake City, Utah.*—The contracts for the Parley's Cañon brick conduit have been awarded as follows: Conduit proper, Du Bois & Williams, for $84,384; grading, Hobson & Wilkinson, $25,250; total, $109,634. The bids, as advertised in the ENGINEERING NEWS, were for a 36-in. brick conduit, 6 miles long.

## ARTESIAN WELLS.

*Guyton, Ga.*—It is reported that the Messrs. Cubbedge have awarded a contract for a well to the Savannah Plumbing Co.

*Aurora, Ill.*—The Board of Public Works has been authorized to spend $3,000 for experimental artesian wells. It is stated that the present water supply is very objectionable.

*Beeville, Tex.*—A. R. Smalley, Houston, has received the contract for a well to yield 100,000 galls. daily; price $3,000. The money has been raised by subscriptions.

*Taylor, Tex.*—It is reported that a well will be sunk by Burkett & Murphy.

*Terrell, Tex.*—An increased water supply from wells or otherwise is desired. Two wells are already in operation. Victor Reinhardt is superintendent.

## IRRIGATION.

*Kendall, Kan.*—The Kendall Irrigation & Manufacturing Co. has been incorporated; capital, $10 000.

*Tribune, Kan.*—The Greeley County Irrigation Water Co. has been incorporated; capital, $5,000.

*Cheyenne, Wyo.*—The Laramie & Scott's Bluff Water and Power Co. has been incorporated; capital, $3,000,000. The company proposes to irrigate 400,000 acres of land located in five counties by means of a ditch 200 ft. wide and 150 miles long, tapping the North Platte River in Laramie Co.

*Evanston, Wyo.*—The Bear River and Yellow Creek Irrigation & Land Co. has been incorporated by William Hinton, Harvey Booth and Anthony Qinn, all of Evanston; capital, $30,000. The project is further described by a press dispatch, as follows:

The ditch will begin at a point in the southwest corner of Wyoming, near the source of Bear River, thence about seven-eighths of a mile down Bear River, thence into Utah, until Yellow Creek is reached, thence down the main branch of Yellow Creek in Utah to Bear River, near Evanston. The starting point is 20 miles south of Evanston. The water will be taken from Bear River, and will water 50,000 acres of arid lands. The ditch will be 20 ft. wide and 5 ft. deep. Work will be commenced as soon as the weather will allow.

*San Angelo, Tex.*—The San Angelo Irrigating & Power Co. has been incorporated; capital, $10,000.

*Montrose, Col.*—The McDowell Ditch Irrigating Co. has been incorporated; capital, $5,000.

*Las Vegas, N. M.*—The Puerta De Luna Ditch & Colonization Co. has been incorporated, with Charles Ilfeld, Max Nordhaus, W. J. Mills and others as directors; capital stock, $25,000.

## SEWERAGE AND MUNICIPAL.

**Sewers.**—*Boston, Mass.*—The Attorney General, on behalf of the Metropolitan Sewerage Commissioners, has asked in the Superior Court for the appointment under the act of 1889 of 3 commissioners to determine the amount to be assessed on each of the cities and towns interested in the system of metropolitan drainage. It was supposed that there would be no objection to application, but the city of Somerville and the towns of Winchester, Everett and Stoneham appeared in opposition, on the ground that the act creating the metropolitan commission is unconstitutional. During the year 14,845 ft. of intercepting sewer have been built. To complete the improved sewerage system as proposed, including sections Nos. 6, 7, 8, 9, and 11 of the Dorchester intercepting sewer, the sewer from Squantum to Moon Island, the sea wall at Moon Island and the pumping station at the east shaft of the Dorchester Bay tunnel will require $350,000.

*Newport, R. I.*—It is proposed to issue bonds for $70,000 for the construction of sewers and streets.

*Newark, N. J.*—A bill has been passed to authorize the formation of a Board of Public Works, to have charge of sewers, streets and other public works.

*East Orange, N. J.*—The total length of the sewerage system is about 28 miles, the extensions during the year amounting to 6,577 ft. There were 296 house connections made during the year, making the total number 1,184. There had only been 6 complaints of stoppage, and all but one had been occasioned by the carelessness of the occupants of the houses. Several improvements had been made in the system.

*Orange, N. J.*—An ordinance providing for a system of sewerage has been introduced into the City Council. The work is estimated to cost over $800,000, including the intercepting sewer, which will be 8 miles long from the city line to the Passaic River near Belleville. The outlet will be near the intake of the Jersey City water-works, but a system will be introduced which will retain the sewage while the tide is flowing up the river and allow it to empty when the tide begins to recede.

*Montclair, N. J.*—At a meeting of the township on March 5 a resolution was adopted providing for, under the judgment of the town committee, an equitable arrangement to be made by coöperating with the city of Orange or any of the towns of Essex Co., which will ensure to Montclair a good system of sewerage which can be built within the legal requirements regulating the expenditures of towns for such purposes. The town committee was requested to call a meeting of the voters to act upon the proposed plan of coöperation.

*Sharpsbury, Pa.*—Plans for a system of sewerage have been prepared by Wilkins & Davidson, who recommend the separate system. They will be of brick, 5½ × 7 ft., and 36 ins. diameter, and of terra-cotta pipes 10 to 24 ins. diameter. The cost is estimated at $75,000.

*Washington, D. C.*—An appropriation of $75,000 has been provided for sewers.

*Salem, Va.*—A report on a sewerage system has been prepared by Mr. L. Chandler, City Engineer. For District No. 1 it recommends 18-in. terra-cotta pipes for the main sewer, 12-in. for branches, 8-in. for laterals, and 6-in. for house connections.

*Knoxville, Tenn.*—The city has been authorized to issue bonds for $500,000 for sewers and other public improvements.

*Wilmington, N. C.*—The vote on the question of issuing sewerage and improvement bonds will be voted upon March 26.

*Atlanta, Ga.*—The sewerage system is to be extended, requiring about 25,000 ft. of sewer pipe.

*Hamilton Co., O.*—The Ohio Senate has passed a bill authorizing the Hamilton Co. villages in the Mill Creek Valley to join in the construction of a main trunk sewer system. The bill provides for the appointment by the Probate Court of Hamilton Co., upon the application of 4 or more of these villages, through ordinances passed by the village councils, of a commission for the construction of a sewerage system for joint use. The cost is not to exceed $150,000, to be borne by the villages according to their population. The levy for the fund to redeem the bonds is not to exceed 1½ mill per annum.

*Cleveland, O.*—Sewerage and street paving bonds will be issued to the amount of $310,000.

*Nelson, O.*—It is proposed to issue bonds for $20,000 for sewers.

*Chicago, Ill.*—Plans for the sewerage for the World's Fair are being prepared by Mr. Wm. S. MacHarg.

*Winnetka, Ill.*—Plans for a sewerage system have been prepared by Mr. Wm. S. MacHarg.

*Denver, Col.*—The Delgany St. sewer will be built by J. E Riley & Co., at a cost not to exceed the engineer's estimate of $196,039. The contract was originally awarded to this firm, but for a smaller size of sewer than is now to be built.

*Seattle, Wash.*—A proposition has been made to establish assessment districts for sewers as for street work, and to place the cost directly upon the property benefited.

*Victoria, B. C.*—Work on the first 30 miles of the sewerage system will be commenced this month. The separate system has been adopted, with flush tanks, and the Shone ejectors. The sewage will be discharged into the Straits of Fuca, about 2¼ miles from the entrance to the harbor.

**Streets.**—*Boston, Mass.*—The cost of the proposed extension of Boylston St. to Brookline Ave. is estimated at $45,000.

*Newark, N. J.*—The Finance Committee has been asked to take steps toward the issue of bonds to pay for street paving. About $740,000 worth of work has been projected.

*Montgomery, Ala.*—The city has issued paving bonds, and will let contracts for Belgian and granite block paving.

*Cincinnati.*—The Board of Public Affairs propose the following street work: Granite, improvements ordered, $535,192; petitioned for, $306,000; suggested, $1,246,000. Asphalt, improvements ordered, $277,815; petitioned for $230,400; suggested, $242,000. Total, $2,837,407.

*Piqua, O.*—It is proposed to issue $15,000 in bonds for street work.

*Hamilton, O.*—The city proposes to issue street improvement bonds for $15,000.

*Detroit, Mich.*—Contracts for stone, brick and wood paving, Berea and Medina stone curbing have been awarded by the Board of Public Works.

*Evanston, Ill.*—The Street Committee have reported in favor of the adoption of a comprehensive system of street improvements.

*Duluth, Minn.*—Several contracts for street work and sewers have been awarded by the Board of Public Works.

*Beatrice, Neb.*—The $42.000 paving and curbing bonds have been sold to Parson, Leach & Co., of New York, at par.

**Lighting.**—*Troy, N. Y.*—The Contracting Board has awarded the contract for gas lighting for streets and public buildings to the Troy Gas Co. at 8 cts. per street lamp per night, and $1.50 per 1,000 cu. ft. for the public offices.

**Garbage Burning**—The City Council of Savannah, Ga., has accepted the two Engle cremators built by the Engle Sanitary & Cremation Co. An Engle cremator has been ordered for the McPherson barracks at Atlanta, Ga., and a proposition has been made to put one in at Columbus, Ga. Garbage cremation is also under consideration at Victoria, B. C.

## ELECTRICAL.

**Electric Light.**—New plants or extentions of existing lines are reported as probable in the following places: Methuen, Mass., address the Lawrence Gas Co., Lawrence, Mass.; Cuero, Tex., address G. Jaeger; Chester, S. C., address P. Hemphill; Roanoke, Va., address G. S. Colgate; Versailles, Ky.; Anderson, S. C., address W. C. Whitner; Plymouth, Ind., address Stevens & Lauer; Vacaville, Cal.; South Manchester, Conn.; Middletown, N. Y., address the Casino; Quincy, Ill., address Weems Bros.; Thompsonville, Conn.; Traverse City, Mich.; Ludington, Mich; East Orange, N. J.; Marcellus, Mich., address J. W. Hoffman; Clarksdale, Miss.; Vergennes, Vt.; Royersford, Pa., address Y. C. Freed; Mayville, N. Y., address L. Bixby; Nashville, Tenn.; Elkin, N.C., address T. J. Lillard; Hyde Park, Mass.; Santa Fe, N. Mex.; Cambridge, O.; Alton, Ill.; Cuyahoga Falls, O.; Aiken, S. C., address G. Gardner, Washington, D. C.; Puyallup, Wash.; Fort Payne, Ala., address the Fort Payne Coal & Iron Iron Co.; Baton Rouge, La., address the Citizens' Electric Light Co.; Key West, Fla., address the Key West Gas & Electric Light Co.; Ocala, Fla., address the Ocala Light & Power Co.; Brownwood, Tex.

*Springfield, Vt.*—The Village Trustees have contracted with the Springfield Electric Co. for 2,000 c. p. lights at $80 per light-year.

*Allegheny City, Pa.*—The Common Council has authorized the issue of $160,000 of electric-light bonds.

*Washington, D. C.*—The District Commissioners have granted permission to the U. S. Electric Lighting Co. to lay about five miles of underground conduits.

*Indianapolis, Ind.*—The following bid for street lighting was recently received by the City Council from the Electric Mfg. Co., of Chicago; prices are per lamp year on a 5-year contract:

| No. of lamps | 460 | 500 | 600 | 700 | 800 |
|---|---|---|---|---|---|
| All-night schedule | $104 | $102 | $100 | $98 | $96 |
| Moonlight " | 94 | 92 | 90 | 88 | 86 |

*Selbina, Ill.*—The Thomson-Houston Co. has offered to install for the town a 30-arc light (1,200 c. p.) plant, with buildings, engines and appurtenances complete, for $4,795.

*Berlin, Wis.*—The City Council has contracted with the Berlin Electric Light Co. for 20 arc lights of 2,000 c. p., for 2 years, at $7 per lamp-month.

*Tacoma, Wash.*—It is reported that the new station in this city is to have a capacity of 2,500 arc and 5,000 incandescent lights.

**New Companies.**—Medina, N. Y., Electric Co.; capital stock, $20,000; incorporators, C. T. Moffett, H. C. Hodgkins, R. J. O'Donnell.——Electrical Expert Co., Chicago, Ill.; capital stock, $25,000; incorporators, H. M. Wolf, F. G. O'Connell, A. A. Bliss.——Continental Electric Construction Co., Chicago, Ill.; capital stock, $250,000; incorporators, W. F. Orrell, O. J. Wheat, L. C. Orrell.——Gouhegan Electric Light & Power Co., Milford, N. H.; capital stock, $60,000; T. P. Dresser, President, and G. A. Beatty, Secretary.—Midland Electric Co., Denver, Colo.; capital stock, $150,000.——Railway Electric & Auto-Penumatic Signal Co., Jersey City, N. J.; capital stock, $500,000.——Athol Gas & Electric Co., Athol, Mass.; capital stock, $250,000; G. C. Moses, President, and J. H. Bickford, Secretary.——Standard Electric Co., Chicago Ill.; capital stock, $100,000; incorporators, W. A. Conover, F. E. Charnley, F. M. Clocke.——Monterey, Cal., Light & Development Co.; capital stock, $25,000; incorporators, E. Ingram, S. H. Smith, D. R. Dodwick and others.——Commercial Electric Light & Power Co., Tacoma, Wash.; capital stock $250,000; W. B. Bushnell, President, and L. G. Bigelow, Secretary.——Osage, Ia., Electric Light Heat & Power Co.; capital stock, $15,000.——Wellwood, N. J., Electric Co.; capital stock, $40,000.——Lethbridge Water Works & Electric Light Co., Lethbridge, Alberta, N. W. T.; capital stock, $100,000; E. I. Galt, Secretary, and C. C. McCaul, Secretary.——Salem, Va., Electric Light Co.; capital stock, $100,000; W. M. Nelson, President, and G. L. Colgate, Secretary.——Keeseville, N. Y., Electric Light & Power Co.; capital stock, $40,000; incorporators, W. D. Rich, H. R. Gardner, H. C. Hill.

| Items. | A. | B. | C. | D. | E. | F. | G. |
|---|---|---|---|---|---|---|---|
| Earth excavation | $.30 | $.27 | $.35 | $.27 | $.28 | $.24 | $.40 |
| Earth excav. and back filling | .43 | .32 | .35 | .38 | .35 | .32 | .40 |
| Rock excavation | .60 | 1.75 | 1.90 | 2.40 | 2.00 | 1.75 | 2.15 |
| Rock excav. and back filling | .85 | 1.80 | 2.00 | 3.00 | 2.30 | 1.90 | 2.15 |
| Embankment | .15 | .26 | .15 | .32 | .45 | .14 | .35 |
| Tunneling earth and timber | 2.00 | 1.50 | 5.00 | 5.60 | 3.00 | 5.00 | 2.15 |
| Tunneling solid rock | 6.00 | 4.00 | 10.00 | 6.20 | 5.00 | 9.00 | 4.75 |
| Concrete masonry | 9.50 | 6.15 | 8.50 | 5.97 | 5.90 | 7.50 | ..... |
| Brick masonry | 12.00 | 12.70 | 10.75 | 8.85 | 8.87 | 11.50 | ..... |
| Cut stone masonry | 18.00 | 54.00 | 12.00 | 12.40 | 30.00 | 25.00 | ..... |
| Rubble masonry | 10.00 | 12.00 | 6.00 | 7.50 | 12.00 | 8.00 | ..... |
| Rubble masonry, laid dry | 6.50 | 8.00 | 5.00 | 5.00 | 5.00 | 6.00 | ..... |
| Riprap | 1.50 | 2.00 | 1.25 | 3.00 | 3.50 | 2.00 | ..... |
| Cement plaster | .25 | .56 | .50 | .34 | .60 | .40 | ..... |
| Lumber in work | 30.00 | 30.00 | 30.00 | 25.00 | 35.00 | 45.00 | ..... |
| Cast-iron pipe, 36-in., laid | 12.00 | 10.10 | 13.50 | 11.68 | 11.43 | 12.00 | ..... |
| Wrought-iron pipe, 36-in., laid | 14.00 | 10.15 | 14.50 | 6.95 | 10.43 | 14.50 | ..... |
| Wooden pipe, 36-in., laid | 5.50 | 4.00 | 4.00 | 3.45 | 7.46 | 7.50 | ..... |
| Total for grading | 25,250 | 28,435 | 30,820 | 38,976 | 34,660 | 28,490 | 35,254 |
| Total for masonry conduit | 116,795 | 104,740 | 115,630 | 84,384 | 94,585 | 106,590 | ..... |
| Grand total | $145,195 | 135,450 | 149,550 | 125,468 | 132,137 | 137,680 | ..... |

## CONTRACTING.

**Street Work.**—*Newark, N. J.*—The contract for square trap block paving on Passaic St. has been awarded to M. Shanley at $1.65 per sq. yd. for paving and 30 cts. for crosswalks.

*Braddock, Pa.*—The following proposals for brick paving have been received by Mr. Wm. Howat, Borough Engineer: Keeling, Ridge & Co., $1.65 per sq. yd.; F. P. Sawders, $1.65; J. H. McQuade, $1.83; J. P. Shaw, $1.85; Chas. Ott, $1.90; McPoland & Graham, $2.03; T. M. Scanlon, $2.10. The paving is to be of vitrified fire brick 9×4 × 2½ ins., laid on edge and grouted with hot pitch and sand. The foundation will be a bed of 2 to 2½ in. broken stone 7 ins. deep, upon which will be a 3-in. bed of clean sand.

**Levees.**—The New Orleans Levee Board has awarded the contract for earthwork on the Upper Protection and Dublin Ave. levees to Louis Louque at 19½ cts. per cu. yd

**Ditch.**—The contract for the dredging work of the Wabash Joint ditch in Mercer Co., O., has been awarded to W. E. Morris, of Dayton, O., at $21.051, about $5,000 less than the estimate. The remainder of the work was let to local bidders at about two-thirds of the estimate. Mr. J. M. De Ford, County Surveyor, of Celina, O., is the Engineer.

**Dredging.**—Contracts were awarded March 10 as follows by Capt. Casey, U. S. Engineer Office, New York, N.Y.: Passaic River below Newark, N. J., R. G. Packard, 30 cts. per cu. yd.; above Newark, Richard Parrott, 35 cts. Channel between Staten Island and New Jersey, T. H. Benton, 26 cts. Arthur Kill, Atlantic Dredging Co., 24½ cts. Elizabeth River, N. J., Richard Parrot, 55 cts. South River, N. J., E. M. Payn, 38¾ cts. Shoal Harbor and Compton's Creek, Elijah Brainard, 24¾ cts. Matawan Creek, N. J., Atlantic Dredging Co., 37½ cts. Shrewsbury River, N. J., P. Sanford Ross, 35 cts. Canarsie Bay, N. Y., Elijah Brainard, 24½ cts.

**Conduit.**—*Salt Lake City, Utah.*—The following bids for the new brick and concrete conduit, 36 ins. diameter, to bring a water supply from Parley's Creek, 6 miles distant, have been received by the Board of Public Works. Mr. A. F. Doremus is the City Engineer, and in charge of this work. The bidders are as follows: A, Hobson & Wilkinson; B, Duval, Mills & Kirk; C, Simon Bamberger & Co.; D, Du Bois & Williams; E, J. S. Morse; F, Harrigan & Kennelly; G, J. W. Sullivan. The contract for grading has been awarded to Hobson & Wilkinson, at $25,250, and the contract for masonry conduit to Du Bois & Williams, at $84,384, making a total approximate cost of $109,634. At certain points cast-iron, wrought-iron or wooden pipe may be substituted for the masonry. The total cost, including right of way, engineering, gate houses, etc., is estimated not to exceed $130,000.

## PROPOSALS OPEN.

**Bridges.**—*Little Rock, Ark.*—Proposals, competitive plans and specifications for highway bridge across the Arkansas River at Main St., with footway and street railway. Masonry or metallic cylinder piers. Channel span 350 ft. c. to c. of piers, 50 ft. above high water. Iron trestle and masonry approach. Plate girder span over the Missouri Pacific R. R. Roadway 22 ft. wide, with floor system for a double track electric railway on the roadway, and 2 sidewalks 5 ft. wide on brackets outside the trusses. Henry Goldmark, Consulting Engineer. Hon Jacob Erb, County Judge. April 7.

*Bradford, Pa.*—Iron highway bridge, 65 ft. clear span, 16 ft. roadway, 2 sidewalks 6 ft. wide. Stone abutments with about 130 cu. yds. of masonry. The City Clerk, March 16

**City Work.**—*New York, N. Y.*—Regulating and grading, curbing, flagging, crosswalks and granite block pavement. Commissioner of Street Improvements of 23d and 24th Wards, 2,656 Third Ave., March 19.

*Cleveland, O.*—Grading, Medina block paving and sewers. C. G. Force, City Engineer. March 20 and 25. April 2.

*Norwood, O.*—Grading, macadamizing, asphalt paving and gutters. D. S. Hosbrook, Engineer, Court House. March 21 and 28.

**Curbing.**—*Holyoke, Mass.*—About 10,000 ft. of granite curbing. M Connor, Chairman of Committee on Sidewalks. April 1.

**Hydrants, Etc.**—*New York, N. Y.*—Hydrants and boxes, stop cock boxes; iron lamp posts and lamps; furnishing and laying water mains. Department of Public Works, 31 Chambers St. March 18.

**Breakwater.**—*Buffalo, N. Y.*—Extending the breakwater about 500 ft. Major Amos Stickney, U. S. Engineer Office. April 4.

**Pier.**—*New York, N. Y.*—Extending pier 25 at North Moore St., North River. Docks Department, Pier A, North River. March 20.

**Boilers and Pipe.**—*Washington, D. C.*—Boilers, water heaters and tanks; cast-iron, wrought iron and galvanized pipe, for Congressional Library building. Bernard R. Green, Superintendent and Engineer, 145 East Capitol St. April 2.

**Paving Blocks.**—*Springfield, Mass.*—Furnishing granite paving blocks during 1891. W. L. Dickinson, Superintendent of Streets. March 18.

## MANUFACTURING AND TECHNICAL.

**Locomotives.**—The Baldwin Locomotive Works, of Philadelphia, Pa., have an order for two steam motors, weighing 56,000 lbs. each, for the Fountain City Ry., of Knoxville, Tenn. A narrow gage engine, weighing about 10 tons, for a logging road, is wanted by F. A. Addington, of Avoca, N. Y.

**Cars.**—The works of the Harvey Steel Car Co., at Harvey, Ill., are nearly completed. The Ensign Car Co., of Huntington, W. Va., has an order for 1,000 freight cars for the Mexican International. The United States Rolling Stock Co., of Anniston, Ala., has an order for 200 freight cars for the Macon Construction Co. The Railroad Equipment Co., of St. Paul, Minn., has leased cars and engines to the Chicago, St. Paul & Kansas City. The Pullman Palace Car Co., of Chicago, Ill., has a large order for sleeping cars for Australia.

**Car Doors.**—Judge Colt is reported to have granted a temporary injunction against the Coburn Trolley Door Co., of Worcester, Mass., in a suit for infringement brought by the Q. & C. Co., successor to the Dunham Mfg. Co.

**Railway Stations.**—The Merchants' Terminal Ry. Co., of St. Louis, Mo., has had plans prepared for a union station on North Broadway to cost $500,000. The Terminal Association also proposes to build a union station in St. Louis. The Baltimore Belt R. R. Co. will build a central station at Baltimore, Md. The Philadelphia, Wilmington & Baltimore will build a new station at Havre de Grace, Md. Plans have been prepared by the Norfolk & Western for a union passenger and freight station at Norfolk, Va., to accommodate all roads using the belt line. The cost will be about $600,000. The contract for the Fort St. union station at Detroit, Mich., has been awarded to Henry George & Son, of Detroit. The station was illustrated and described in ENGINEERING NEWS, Jan. 31, 1891

**Rails.**—The Bargion compound rail is being tried on the Southern Pacific. It is made at the Union Iron Works, of San Francisco, Cal.

**Public Buildings.**—Plans for a court house and gaol to cost $12,000 for Warwick County are being prepared by Geo. C. Moser, of Norfolk, Va. At Stanton, Ky., a court house is to be erected at a cost of $13,000, and a gaol at a cost of $5,600. A jail is proposed at Piedmont, Ala.

**Road Roller.**—Major Ginter, president of the Brook Turnpike Co., of Richmond, Va., has purchased an Aveling & Porter steam road roller for use on the roads belonging to the company.

**Water Tube Boilers.**—The Campbell & Zell Co., of Baltimore, Md., has orders for the Zell water tube boiler from the Hampton & Newport News Electric Ry., of Hampton, Va., and the Metropolitan Ry., of Washington, D. C.

**The Pittsburg Testing Laboratory** has opened an office in the Rookery Building, Chicago. Mr. W. A. Aiken, M. Am. Soc. C. E., is in charge. An office has also been opened at Cleveland, O., in charge of James Ritchie.

**The Reading Rolling Mills Co.,** of Pottstown, Pa., recently rolled for Messrs. Cofrode & Saylor some angle irons, 4 × 4 × ⅜ in. and 123 ft. long, for bridge work.

**Companies.**—Davis Coupling Equipment Co., of Albany, N. Y., to manufacture automatic car couplers; incorporators, A. H. S. Davis, J. W. Husted and John W. Stokes; capital stock, $100,000. Schofield Mfg. Co., of Newark, N. J.; to manufacture railway supplies; incorporators, A. J. Schofield, of Brooklyn, N. Y.; J. C. Beach, Bloomfield, N. J.; capital stock, $100,000. South Chicago Foundry Co., of Chicago, Ill.; incorporators, L. Evans, Frederick Arndt and J. A. Prescott; capital stock, $50,000. Taylor Electric Signal Co., of Chicago, Ill.; incorporators, F. L. Merrill and Geo. W. Hett; capital stock, $500,000. Ashland Lime & Cement Co., of Ashland, Wis.; incorporators, W. O. Lamb, T. Edwards and J. A. Quain; capital stock, $40,000. Probst Construction Co., of Chicago, Ill.; incorporators, Herman Probst, P. T. P. Mueller and Bernard Lishter; capital stock, $50,000. Bushnell Metal Wheel Works, of Bushnell, Ill.; incorporators, James Cole, J. B. Spicer and S. Bonfill; capital stock, $200,000. Milwaukee Southern Iron Co., of Milwaukee, Wis; incorporators, C. H. Hamilton, O. A. Mueller and Wm. Shimwell; capital stock, $30,000.

**Metal Market Prices.**—*Rails.*—New York: $30.75 old rails, $22 for iron and $17.25 for steel. Pittsburg: $26.50 to $27; old rails, $25.50 for iron, and $18.25 for steel. Chicago: $31 to $32.50; old rails, $23 to $23.25 for iron and $15 to $17 for steel.

*Foundry Pig Iron.*—New York: $14 to $16. Pittsburg: $15 to $17. Chicago: $14.50 to $16.

*Track Materials.*—New York: steel angle bars, 1.75 to 1.8 cts.; spikes, $1.9 to $1.95; track bolts, 2.65 to 2.75 cts. with square, and 3.1 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.9 to 1.95 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2.1 cts.; track bolts, 2.8 to 3 cts. with hexagon nuts.

*Pipe.*—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

*Lead.*—New York, 4.3 to 4.35 cts. Chicago, 4.1 cts. St. Louis, 4.1 cts.

*Structural Material.*—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 to 2.1 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.05 to 2.25 cts.; steel plates, 2.05 to 2.15 cts. for tank, 2.35 to 2.6 cts. for shell, 2.6 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 to 2.1 cts.; tees, 2.85 cts.; universal iron mill plates, 2.1 cts.; sheared steel bridge plates, 2.3 to 2.35 cts.; refined bars, 1.9 cts.; steel plates, 2.25 to 2.35 cts. for tank, 2.6 to 2.7 cts. for shell, 2.8 to 2.9 cts. for flange, 4.25 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.65 to 2.75 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.